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UNITED STATES DEPARTMENT OF AGRICULTURE

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RED ALDER OF THE PACIFIC NORTHWEST

ITS UTILIZATION, WITH NOTES ON GROWTH AND MANAGEMENT

By

HERMAN M. JOHNSON, Forest Inspector, EDWARD J. HANZLIK, Forest Inspector, and
WILLIAM H. GIBBONS, in Charge, Office of Forest Products, Portland, Oreg.
Forest Service

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IMPORTANCE

Red alder (*Alnus rubra*), although a wood of comparatively little importance outside of the region where it is found, is yet the leading hardwood of the Pacific Northwest. The red alder cut in 1923 amounted roughly to thirteen and one-half million board feet, or only 0.2 per cent of the total cut of hardwood lumber in the United States. Its importance locally is due both to the intrinsic qualities of the wood and to the scant supply of other commercial hardwoods throughout its range.

Because of its color, almost white to light reddish brown, its medium weight, and the ease with which it may be worked, red alder is well adapted for the manufacture of turned and flat parts of furniture, chairs, novelties, and the like. It is especially valuable also in the manufacture of three-ply and five-ply panels, serving both as cores and cross-bands. Its use for this purpose appears to be increasing rapidly. The growth of the furniture and similar wood-using industries of the Pacific Northwest may indeed be said

The commercial range of western birch in this country is confined to western Washington, more particularly to the region adjacent to the Canadian boundary. Across the border it extends well north into British Columbia. Users of this wood are of the opinion that the merchantable supply of birch in Washington does not exceed two or three million board feet. The supply in British Columbia, where conditions are more favorable to its growth, is said to be much larger.

Red alder is one of the conspicuous hardwood trees of the Pacific coast. It grows naturally from southeastern Alaska to southern California, but its commercial range is limited mainly to moist situations in western Oregon and Washington. Throughout the greater part of its range, it occurs as a relatively small-sized tree. Along streams, near springs, in river bottoms, and on well-watered slopes, however, it commonly forms pure stands of commercial-sized timber. On the lower slopes of the coast mountains of Washington and Oregon red alder sometimes grows in practically pure stands over fairly large areas, and takes possession of burned or cut-over lands which have been slow to reforest with conifers.

It should be recognized that thoroughly reliable data on the supply and distribution of red alder can be obtained only by a thoroughgoing survey, something that has never been attempted. Certain general regions where the tree reaches its best development are known, and timbermen and farmers as a result of their observations are in a position to point out other localities. For more detailed information, however, those desiring a supply of alder stumpage are put to the necessity of making their own surveys.

Single compact logging units containing 500,000 board feet of merchantable alder, or alder that will produce logs of the size shown in Figure 1, do not seem to be numerous. Units containing 100,000 board feet, however, are of frequent occurrence. Areas extending for several miles along streams will sometimes cut out more than 500,000 feet, but they are exceptional.

The merchantable stand of red alder in Oregon and Washington is estimated at about 1,110,000,000 board feet (Oregon, 750,000,000; Washington, 360,000,000). The Oregon acreage, estimated at 75,000 acres, lies mainly within 30 miles of the coast. The Washington stands, found somewhat farther inland, are estimated to cover 30,000 acres. Not all of this estimated supply, however, is available at present; in fact, much of it, because of the character of its occurrence and the absence of transportation facilities, is inaccessible.

ANNUAL CONSUMPTION

Statistics dealing with red alder are very meager, but such as there are indicate that consumption of this wood is increasing rapidly. In 1910 Oregon and Washington used nearly 2,685,000 board feet of red alder. A careful survey of the requirements for 1923 indicates that the consumption had risen in 13 years to 13,456,000 board feet, all of which was cut in these two States.[1] Oregon consumed 5,858,000 board feet, and Washington 7,598,000. These figures include the timber used in veneer production, amounting to

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[1] Figures for both years are much higher than those reported by the Bureau of the Census for red alder production in Washington and Oregon. This is explained by the considerable number of small mills cutting red alder, which, because of their size, did not submit reports.

290,000 board feet, but not that used for fuel by ranchers and in the small settlements.

As some of the lumber produced in Washington was consumed in Oregon, and some of the logs produced in Washington were sawed in Oregon, it is not possible to determine the 1923 production definitely as between the two States. It is estimated, however, that Oregon produced 3,559,000 board feet (lumber tally) of red alder logs (including veneer logs) and 4,598,000 feet of lumber, and that Washington produced 9,897,000 feet of logs and 8,568,000 feet of lumber.

As has been intimated practically the entire cut of alder is utilized by the secondary wood-using industries of Oregon and Washington, chiefly furniture factories. In 1923 about 30 per cent of the logs were sawed by the wood-using factories, the remainder by small operators who sell their lumber output in the open market.

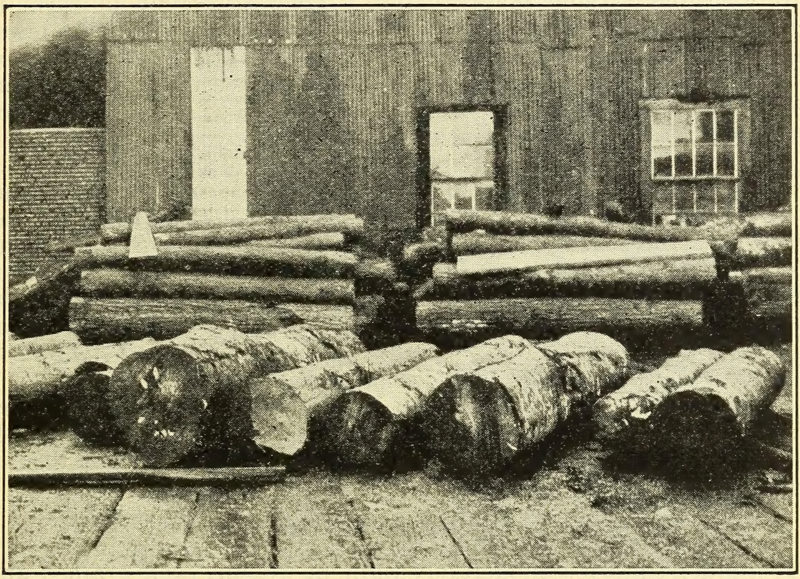

FIG. 1.—TYPICAL ALDER LOGS AS DELIVERED TO A WASHINGTON CHAIR FACTORY

PROPERTIES OF RED ALDER WOOD

GENERAL DESCRIPTION

A cross section of the trunk of an alder tree shows no plainly visible distinction between heartwood and sapwood, for both are nearly white and of high moisture content. Shortly after being cut the wood turns to a light, reddish brown, or sometimes when sawed in the fall to a light golden yellow. When fully seasoned the surface of alder lumber is pale saffron in color. This is in no sense undesirable; in fact, as the bulk of the wood is stained to imitate walnut or mahogany, it is an advantage. The outer inch or two of the trunk of merchantable trees is composed of slowly grown or narrow-ringed wood, but lumber sawed from this rim does not differ in general appearance from that cut nearer the heart.

Red alder has a straight, fine, uniform grain, the narrow bands of summer wood appearing only as fine lines in a radial section. The wood has no definite figure, but sometimes the lumber shows streaks running in a vertical direction, known as "pith-ray flecks." These streaks are caused by the larva or grubs of certain insects that live in the cambium during the growing season.[2] They are not peculiar to alder; similar flecks are found in birch, cherry, and a number of other woods.

If properly cared for, red alder does not warp, check, shrink, or swell appreciably in place. It turns well and takes a fair polish. It also takes glue, paint, and enamel well, and makes an excellent imitation mahogany or walnut when stained.

STRUCTURE AND IDENTIFICATION

In red alder the pores are comparatively small, being invisible or barely visible without magnification. They are fairly uniform in size and evenly distributed, except that they are often slightly fewer in the extreme outer portion of each yearly growth—a condition which helps to mark the otherwise inconspicuous rings. The fibers are evenly distributed among the pores. (Fig. 2, A–3.) Pitch flecks may or may not be present.

The medullary rays are mostly one cell wide, rarely two cells. Occasionally they combine to form compound rays, very distinct on the end grain and more or less so on longitudinal surfaces. Sometimes these compound rays contain dark coloring matter and are then plainly visible on the faces of veneer or dressed lumber. The transverse spacing between the compound rays as seen on the end grain is very irregular, varying from less than one-sixteenth of an inch to over 1 inch. These compound rays are the most distinctive structural feature of alder wood. (Fig. 2, A–2.)

Seasoned red alder can easily be distinguished from other western hardwoods, except cottonwood, by its relatively light weight. It can be distinguished from cottonwood by its light reddish brown color and compound rays.

PHYSICAL AND MECHANICAL PROPERTIES

Red-alder timber is moderately light in weight, even grained and soft in texture, and has low strength values in comparison with "strong" woods. Compared on a basis of density or weight, it has nearly average values for most of its properties except that it has greater stiffness than the average. In the classification of woods by the Forest Products Laboratory of the Forest Service, according to the results of tests for each of six physical and mechanical properties, red alder is classified as follows:

PROPERTY	CLASSIFICATION
Density or weight.	Moderately light.
Strength as a beam or post.	Moderately weak.
Hardness.	Moderately soft.
Shock-resisting ability.	Moderately poor.
Stiffness.	Moderately stiff.
Shrinkage.	Very moderate.

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[2] Brown, H. P., Pith-ray Flecks in Wood. U. S. Dept. Agr., Forest Serv. Circ. 215, 15 pp., illus. 1913.

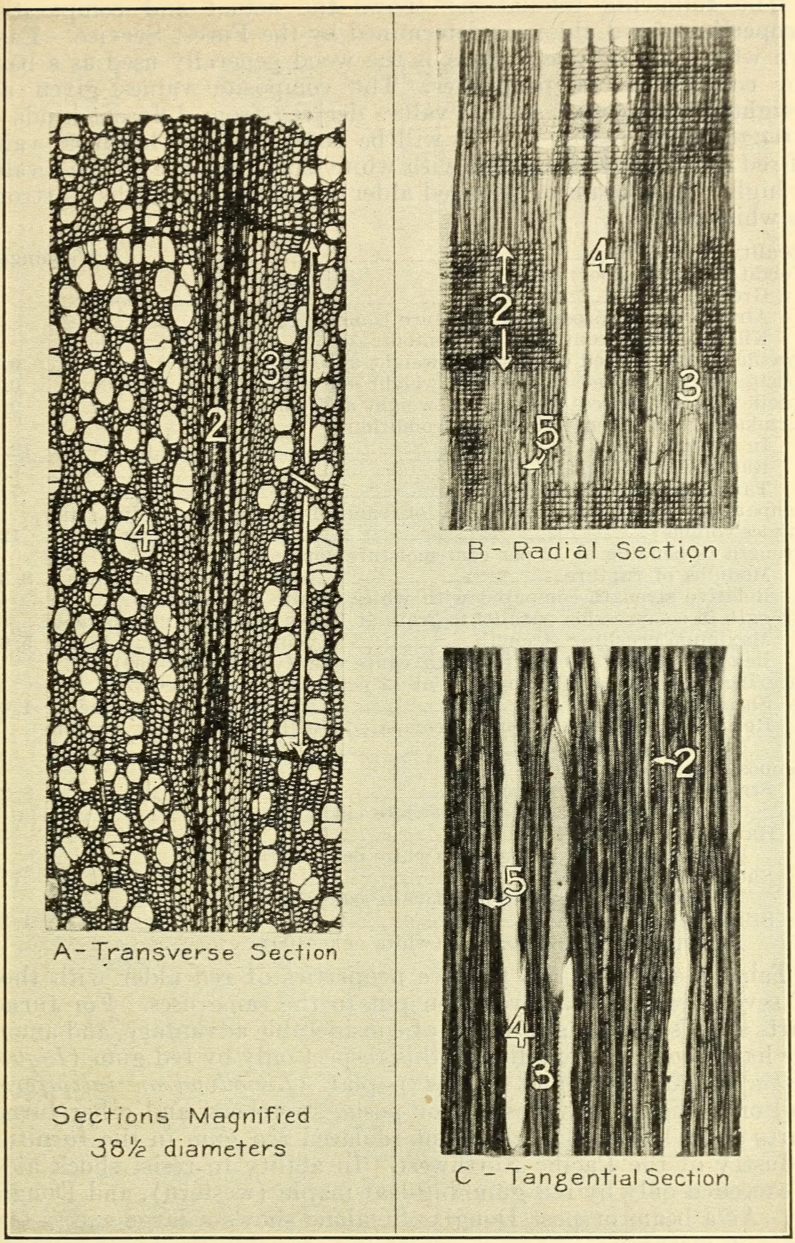

FIG. 2.—HIGHLY MAGNIFIED SECTIONS OF RED ALDER, SHOWING STRUCTURE

The numbers on the photographs refer to the following: (1) Width of annual ring; (2) medullary or pith ray; (3) wood fiber; (4) vessel; (5) wood parenchyma

The following tabulation[3] shows the actual and comparative properties of red alder, as determined by the Forest Service. Eastern white oak (*Quercus alba*) is the wood generally used as a basis for comparison of properties. The composite values given are weighted averages of several values derived from different kinds of strength tests. (Fig. 3.) It will be noted that the hardness value of red alder is low compared with white oak, while the stiffness value is high. As a beam or post red alder is nearly four-fifths as strong as white oak.

Locality where grown		Washington
Weight per cubic foot:		
Green	pounds	46
Air-dry, 12 to 15 per cent moisture content	do	28
Kiln-dry, 8 per cent moisture content	do	27
Specific gravity, based on oven-dry weight and volume when green		0.37
Specific gravity, based on oven-dry weight and volume when oven-dry		0.43
Specific gravity, based on oven-dry weight and volume when air-dry		0.42
Shrinkage from green to oven-dry condition:		
In volume	per cent	12.6
Radial	do	4.4
Tangential	do	7.3
Comparative shrinkage (one-third of sum of tangential, radial, and twice volume)	per cent	12.3
Strength in bending at 12 per cent moisture content:		
Modulus of rupture	pounds per square inch	9,380
Relative strength compared with white (white oak=100)		62
Strength in compression parallel to grain at 12 per cent moisture content:		
Maximum crushing strength	pounds per square inch	5,630
Relative strength compared with white oak (white oak=100)		77
Shearing strength parallel to grain at 12 per cent moisture content:		
Shearing strength	pounds per square inch	1,045
Relative shearing strength compared with white oak (white oak=100)		50
Composite values:		
Strength as a beam or post		8,214
Compared with white oak (white oak=100)		79
Hardness		456
Compared with white oak (white oak=100)		44
Shock-resisting ability		7.33
Compared with white oak (white oak=100)		57
Stiffness		1,375
Compared with white oak (white oak=100)		91

Table 1 compares the relative properties of red alder with those of several woods that are often put to the same uses. For turned parts alder's greater stiffness is of considerable advantage, and among the hardwoods it is excelled in this respect only by red gum (*Liquidambar styraciflua*) and yellow poplar (*Liriodendron tulipifera*), and only slightly by these. For posts, stretchers, and other turned parts alder has to a large extent replaced red gum in the furniture industry of the Pacific Northwest. In ability to resist shock alder is exceeded only by red gum, big-leaf maple (western), and Douglas fir. As a beam or post Douglas fir alone shows a large excess over alder in strength.

Alder is proving the equal of basswood (*Tilia glabra*) and yellow poplar for colors in high-grade veneered panels. In general woods

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[3] Based partly on data taken from the following bulletin: Newlin, J. A., and Wilson, T. R. C., Mechanical Properties of Woods Grown in the United States. U. S. Dept. Agr. Bul. 556, 47 pp., illus. 1917. Partly on subsequent investigations by the Forest Products Laboratory, Madison, Wis.

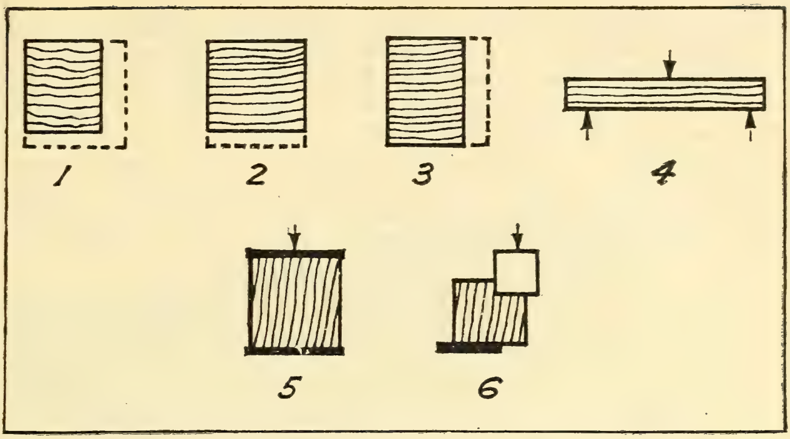

FIG. 3.—ILLUSTRATION OF PHYSICAL AND MECHANICAL TESTS

(1) Shrinkage in volume; (2) radial shrinkage; (3) tangential shrinkage; (4) strength in bending; (5) strength in compression parallel to grain; (6) shearing strength parallel to grain

with a low specific gravity and the least shrinkage are most desired for core stock. Table 1 shows red alder to be lower in specific gravity than the other woods listed, except basswood, yellow poplar, and western hemlock, of which the two former have a slight advantage. Practically the same relation obtains in the case of air-dried material. Red alder shrinks less than either basswood, red gum, or Douglas fir, but somewhat more than the other woods listed.

TABLE 1.—*Properties of red alder compared with other woods put to the same uses*[1]

Species	Specific gravity[2]	Weight		Shrinkage[3]			Strength[4]		Composite values				
		Air-dry	Green	Volume	Radial	Tangential	(A) Bending	(B) Crushing	Strength as a beam or post	Hardness	Shock resisting ability	Stiffness	Comparative shrinkage
Red alder	100	100	100	100	100	100	100	100	100	100	100	100	100
Red gum	123	125	109	119	118	136	110	113	105	124	139	102	122
Basswood	93	93	89	125	150	127	89	80	77	62	75	90	128
Chestnut (Castanea dentata)	107	107	120	92	76	92	88	91	86	104	99	79	90
Yellow poplar	98	96	83	90	93	95	93	89	88	80	77	104	92
Big-leaf maple	118	121	102	92	84	97	109	100	108	151	109	94	92
Western hemlock (Tsuga heterophylla)	100	104	89	92	102	108	109	107	109	99	88	109	97
Douglas fir (Pseudotsuga taxifolia) (Oregon and Washington)	121	117	82	100	114	108	118	131	125	123	111	143	103
Western white pine (Pinus monticola)	105	103	85	91	93	101	98	105	99	78	99	111	93

[1] Based partly on data from the following bulletin: NEWLIN, J. A., and WILSON, T. R. C. MECHANICAL PROPERTIES OF WOODS GROWN IN THE UNITED STATES. U. S. Dept. Agr. Bul. 556, 47 pp., illus. 1917; partly on subsequent investigations by the Forest Products Laboratory.

[2] Based on oven-dry weight and volume when oven-dry.

[3] From green to oven-dry condition, expressed in percentage of dimension when green.

[4] Strength at 12 per cent moisture content: (A) Modulus of rupture in bending; (B) compression parallel to grain (maximum crushing strength).

DURABILITY

Red alder logs left lying in damp situations will show signs of incipient decay within three or four weeks. A shipment of logs used at the Forest Products Laboratory for heat-treatment tests showed within a short time after they were stored in the yard abundant decay from the white rot so common in this wood, and produced by the two fungi, *Polystictus versicolor* and *Polystictus hirsutus*.[4] The life of alder posts will not exceed two or three years. Table 2 gives the estimated relative durability of red alder and several other species of the Pacific Northwest compared with eastern white oak.

TABLE 2.—*Durability of red alder compared with other woods under similar conditions which permit decay*

Species	Estimated relative durability
Commercial white oak (eastern United States)	100
Red alder	25– 35
Western red cedar	125–175
Douglas fir (average mill-run)	75– 85
Western hemlock	35– 55
Sitka spruce	35– 50

Red alder is reported as being used to some extent for piling in salt water, but only in locations where the piling is not subject to abrasion. Under such conditions it is said to be relatively free from the attack of marine borers which destroy untreated piling of most woods. The work of the San Francisco Bay Marine Piling Committee includes a test of red alder in that harbor. After nearly two years of service alder piles with the bark intact had not been attacked by borers, while the wood of those with the bark missing was found to be largely destroyed as a result of the ravages of lemnoria. Since the bark is easily abraded, this suggests that red alder has very little value for marine construction even in protected locations.

SEASONING

The seasoning of red alder, even lumber of high moisture content, does not present any special difficulties. Practically the entire cut is kiln-dried and much of it from the green condition, although some manufacturers believe that lumber that has been air-seasoned for 60 to 90 days before being placed in the kiln gives a stock of better quality than that kiln-dried direct from the saw. If the stock is partially seasoned, close control of temperature, humidity, and air circulation in drying is of less importance than if the stock is green at the time it is placed in the kiln.

Green alder lumber, regardless of the method of seasoning, should be piled in such manner as to insure adequate circulation of air throughout the entire pile or load. This is accomplished by means of foundations not less than 18 inches high at the low point, by keeping the yard free of weeds, and by means of wide spaces between the boards. Close piled, the wood will begin to deteriorate within four or five days during the summer months, and in the winter months within two or three weeks. If it is left in this condition for any length of time serious damage from mold or fungi is likely to result, the mold discoloring the wood, the fungous growth decomposing the parts attacked. Lumber cut from logs infected with decay organisms naturally contains these early stages of decay. Under the conditions of moisture and temperature that may occur in the early stages of kiln drying, or in the close piling of green lumber, the wood-rot fungi may develop on the surface of the boards in a form closely resembling mold growth. Commercial kiln conditions and steaming processes are effective in sterilizing infected wood up to and including pieces 4 inches square.

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[4] Hubert, E. E., Effect of Kiln Drying, Steaming, and Air Seasoning on Certain Fungi in Wood. U. S. Dept. Agr. Bul. 1262, 20 pp., illus. 1924.

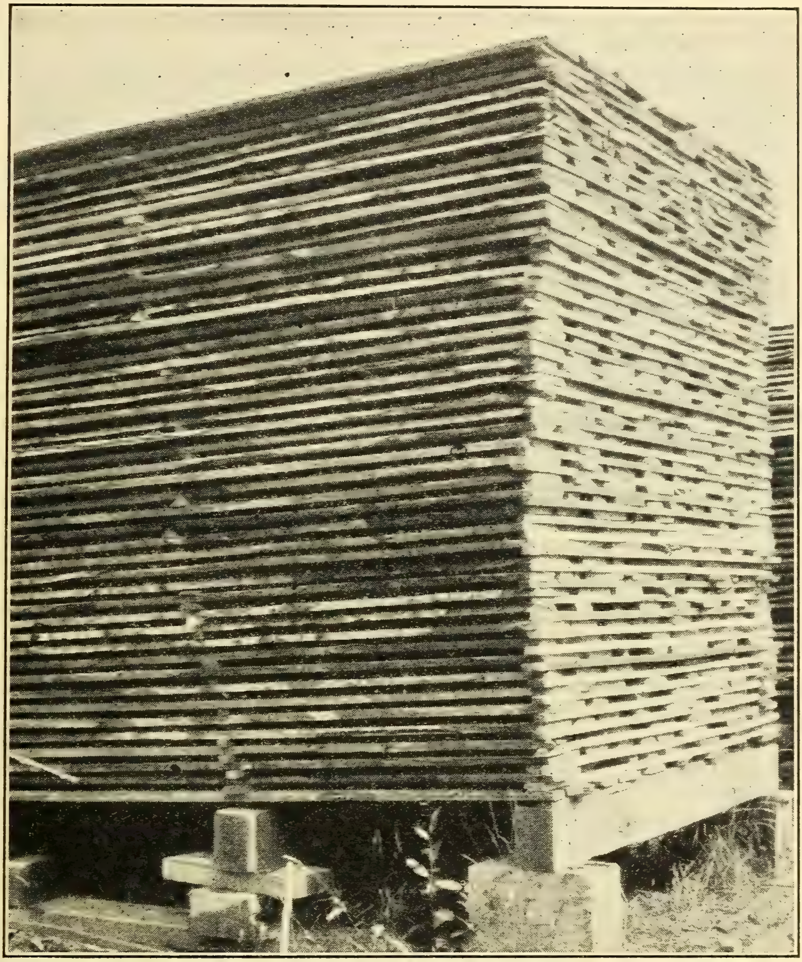

FIG. 4.—ALDER LUMBER PILED FOR AIR SEASONING IN SUMMER

For best results the center stickers should always be in vertical alignment. Piles should be well covered in winter, with an overhang sufficient to protect both sides and ends

In air seasoning red alder special attention should be given to the character, number, and placing of the stickers if the degrade is to be kept to the minimum. Piles should never be "self-stuck" where the lumber is to be left in this condition for any length of time. Where the lumber is to be partially or wholly air seasoned, the stickers (usually made of Douglas fir) should preferably be 1 inch thick and 2 or 3 inches wide and thoroughly seasoned. Too much care can not be exercised here, for it seems that under the best possible conditions for air seasoning alder will end check to some extent. End checking may, however, be reduced to a minimum by placing the outer stickers so that they project slightly beyond the ends of the boards. (Fig. 4.) This will also tend to prevent the loss through splitting likely to occur when there is a considerable overhang at the end of the pile. The distance between stickers should not exceed 4 feet, for warping of the lumber often results when they are placed farther apart. (Fig. 4.)

The rate of drying in the air varies, of course, with the season, size of stock, and method of piling. To air dry red alder lumber thoroughly to a moisture content of 14 to 18 per cent requires from 6 to 9 months.

Although natural-draft kilns, either of the progressive or compartment type, are generally used in the artificial drying of red alder lumber, the fact that other types of kilns are not used more extensively with this species has no special signficance. Lumbermen of the Pacific coast region are possibly more familiar with the natural-draft kiln. Then, too, it is the cheapest type to install. The fact that a progressive kiln with relatively lower flexibility and accuracy of control can be used satisfactorily indicates that red alder is not a difficult wood to dry. Operating instruments are in most cases limited to temperature recorders. In addition, humidities are occasionally determined by means of a wet and dry bulb hygrometer.

The practice in kiln-drying alder is to flat pile the lumber, leaving 2 to 4 inch spaces between the boards in a layer. The amount of space to leave in any particular case is a matter of judgment and depends on the circulation. When the circulation is poor, resulting in uneven drying, a flue in the center of the pile is provided. The stickers, usually 1 inch thick and 1½ inches wide, are placed 4 feet apart. In the case of thick stock the spacing between the stickers may be increased. Where the boards warp, as in the middle of the pile shown in Figure 5, closer spacing must be used, and greater care must be exercised in the other steps of piling.

No schedule for drying alder satisfactorily in the shortest length of time has ever been worked out. Manufacturers seem to rely entirely on the judgment of the kiln operators, with the result that schedules used differ widely.

Green 1-inch stock is dried to a moisture content of 12 to 7 per cent in from five to nine days. The initial temperatures used at different plants vary from 120 to 170° F., with the final temperatures ranging from 160 to 200° F. All operators are agreed that a high humidity, averaging from 60 to 80 per cent, must be maintained throughout the drying. Both green and partially air-seasoned stock is steamed at the beginning of the run, also during drying if the condition of stock demands.

It takes from 14 to 28 days to kiln-dry green 1½ to 2 inch stock. Stock of this thickness is being successfully dried to a moisture content of 12 per cent in 14 days, with temperatures ranging from 100° F. at the beginning of drying to 160° F. at the close. A relative humidity of 60 to 70 per cent is maintained during the early part of the run, dropping to 25 or 30 per cent at the end. Where the drying is forced, through the use of high temperatures and low humidities, honeycombing is likely to result (especially with thick stock), as well as checking, splitting, warping, and cupping.

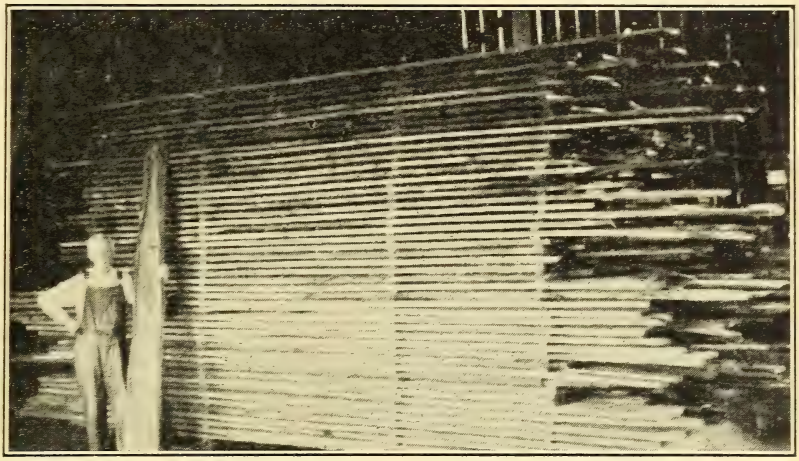

FIG. 5.—ALDER LUMBER, END OF KILN-DRYING RUN

The warping in the center section is due to the use of too few stickers, which should not be more than 4 feet apart

Although the Forest Products Laboratory has worked out drying schedules for a number of woods, no schedule based on actual drying tests has thus far been developed for red alder. It would seem, however, that schedules developed for basswood, yellow poplar, and cottonwood could be safely applied to the kiln-drying of alder. All are diffuse-porous woods, and there is a marked similarity in essential physical characteristics, as is shown in Table 3. It will be noted that the comparative shrinkage of red alder, green to oven dried is less than that of basswood and cottonwood and more than that of yellow poplar.

TABLE 3.—*Essential properties of red alder, yellow poplar, basswood, and cottonwood with reference to kiln drying*

Species	Specific gravity based on oven-dry weight		Weight per cubic foot		Comparative shrinkage, green to oven dry
	Green wood	Oven-dried wood	Air dry	Kiln dry	
			Pounds	*Pounds*	*Per cent*
Red alder	0.37	0.43	28	27	12.3
Yellow poplar	.37	.42	28	27	11.3
Basswood	.33	.40	26	25	15.8
Cottonwood	.37	.43	29	28	13.8

TABLE 4.—*Schedules suggested for drying red alder*[1]

Moisture content (per cent)	Schedule I			Schedule II		
	Dry-bulb temperature	Wet-bulb temperature	Relative humidity	Dry-bulb temperature	Wet-bulb temperature	Relative humidity
	°F.	*°F.*	*Per cent*	*°F.*	*°F.*	*Per cent*
Initial	140	132	79	135	128	81
40	145	135	75	140	130	75
30	150	137	70	145	133	71
25	155	136	59	150	132	60
20	160	135	50	155	131	51
15	165	127	34	160	124	35
10 to final	170	116	20	165	112	20

[1] Schedule I is for basswood and yellow poplar; Schedule II is for cottonwood.

Table 4 gives drying schedules recommended by the Forest Products Laboratory: Schedule I for basswood and yellow poplar, and Schedule II for cottonwood. One or the other of these schedules should give satisfactory results with red alder. It should be borne in mind, however, that the tendency of different woods to check is an individual characteristic, at least to a large extent, and that checking does not follow the relative density or shrinkage of the wood. For example, maple checks more easily than birch, although both are of about the same density. Therefore, while the drying schedules for yellow poplar and basswood should prove satisfactory for red alder, it is recommended that higher humidities be used if excessive checking is encountered.

These schedules are intended to be applied by means of kiln samples, the changes in temperature and humidity being made as the moisture content of the samples passes the percentages indicated. It should be possible to obtain good results with faster drying, but the use of schedules more severe than these will require most careful judgment on the part of the kiln operator.

Preliminary steaming is recommended for the relief of air-drying stresses in partly dry stock. The temperatures may be from 10° to 15° above the starting point of the schedule. One-inch stock with a moisture content of less than 18 per cent should be subjected to a humidity of 70 or 85 per cent for a period of 24 to 30 hours, depending on the severity of the stresses present in the stock. Preliminary steaming is also recommended for green stock, not to relieve stresses, but as a convenient means of bringing the stock up to drying temperature. It is not necessary to steam green stock so long as partly seasoned stock, one hour per inch of thickness being sufficient.

The schedules are equally applicable to green and to partially dried stock. The operator should start at the point of the schedule corresponding to moisture content, disregarding everything above that point, just as if the previous drying had been done in the kiln in accordance with the upper part of the schedule.[5]

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[5] Those interested in a discussion of the fundamental facts about the drying of wood are referred to the following bulletin: Thelen, R., Kiln Drying Handbook. U. S. Dept. Agr. Bul. 1136, 64 pp., illus. 1923. The major portion of the bulletin deals with the kiln drying of lumber, but there are also included specific suggestions concerning the drying of other forms of wood. The general information is applicable to all kinds of drying.

UTILIZATION BY INDUSTRIES

Industries using red alder are considered as belonging in one of two classes, depending on the form of raw material used: (1) Those which depend entirely upon the log or bolt and (2) those which use mainly lumber or dimension stock for further manufacture into various products. The former class is termed primary and the latter secondary.

All the red alder cut in Oregon and Washington in 1923, so far as reported, was consumed by the secondary wood-using industries of these States in the form of logs or lumber, excepting only that used for veneer and for fuel.

Table 5 shows the relative demands made on alder by the wood-using industries of Oregon and Washington in 1910 and 1923. Each of these industries is discussed individually in the following pages, and the particular articles manufactured by them are enumerated.

TABLE 5.—*Summary of red alder used in Oregon and Washington, 1910 and 1923*

Industry	1910	1923
	Board feet	*Board feet*
Furniture	792,500	9,653,000
Chairs and chair stock	625,000	2,410,000
Woodenware and novelties	20,000	560,000
Veneer		290,000
Paper plugs		250,000
Fixtures	196,000	105,000
Miscellaneous		100,000
Brushes and brooms		40,000
Apiarists' and dairymen's supplies		20,000
Handles	361,700	15,000
Laundry appliances		10,000
Motor vehicles		3,000
General millwork	436,000	
Columns	240,000	
Saddles and stirrups	8,000	
Pulleys	5,500	
Total	2,684,700	13,456,000

PRIMARY INDUSTRIES

LUMBER

Practically all the alder lumber produced in Oregon and Washington is used by the secondary wood-using industries of these States. Over 70 per cent of it, however, is sawed by relatively small concerns engaged solely in the production of alder lumber. In 1923 these "independent" alder mills produced 9,361,000 board feet of lumber. The rest of the lumber cut, or 3,805,000 feet, was produced by the secondary industries themselves, largely from purchased logs.

VENEER

Very little alder veneer is produced at present, and most of it is used by the furniture industry. In 1923, 275,000 feet of alder was consumed for rotary-cut veneer and 15,000 feet for sliced veneer.

Rotary-cut veneer.—Logs to be suitable for the manufacture of rotary-cut veneer must be at least 12 inches in diameter at the small end, reasonably clear, straight, and sound.

The usual methods of manufacture are followed. The logs, cut into 4-foot lengths, are boiled in water for 48 hours, after which they are revolved rapidly against a fixed knife, which peels off a thin, continuous sheet. Sometimes two lathes of different sizes are used, the smaller one peeling the log down to a 4½-inch core. The veneer is usually cut one-sixteenth of an inch in thickness.

This class of veneer is used largely by the furniture industry in the production of built-up lumber, or plywood. Strong and light in weight, alder plywood makes very satisfactory drawer sides, backs, and bottoms. The veneer is also used as a core and cross-banding stock in the manufacture of high-grade panels.

Sliced veneer.—Woods-run logs, which cost about $18 per thousand feet delivered at the plant, are used in the production of sliced veneer. The logs are first squared and then dropped against a sharp knife extending the full length of the log. Preliminary boiling or steaming is not always necessary if the logs are sliced while in the green condition. Sliced alder veneer is usually cut one-sixteenth of an inch thick.

Most of the sliced veneer produced from alder is used in the manufacture of wire-end dishes for containing butter, lard, etc.; also grape baskets and berry hallocks.

PULP AND PAPER

Red alder has been used only to a very limited extent, if at all, in the production of commercial pulp. Experiments conducted at the Forest Products Laboratory indicate, however, that it is adapted for pulping by the soda process, which is used almost entirely for the reduction of soft, short-fibred, deciduous wood, such as aspen (*Populus tremuloides*), black cottonwood, red gum, basswood, etc. The results obtained from these experiments on alder, in fact, were practically the same as from pulping black cottonwood (an unexcelled wood) by the soda process. Other than its extreme susceptibility to decay, there seems to be no reason why red alder would not make an excellent pulp wood for the manufacture of soda pulp.

DESTRUCTIVE DISTILLATION

Distillation tests made at the Forest Products Laboratory suggest that red alder will yield a smaller quantity of crude alcohol and acetate of lime than beech (*Fagus grandifolia*), sweet birch (*Betula lenta*), and sugar maple (*Acer saccharum*), the chief hardwoods used by the distillation industry of the United States. The average yields of red alder, in comparison with the three standard species, are given in Tables 6 and 7.[6] In Table 6 the yields are shown as a proportion of the oven-dry weight of the wood distilled. It is on this basis only that results independent of varying percentages of moisture in the material and of differences in the weight of unit volumes can be expressed. In Table 7 the yields are shown in commercial units, gallons of 82 per cent crude wood alcohol and pounds of 80 per cent gray acetate of lime per cord of air-dry wood.

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[6] Tests were made in the same way as those reported in the following bulletins:

Hawley, L. T., and Palmer, R. C., Yields From the Destructive Distillation of Certain Hardwoods. U. S. Dept. Agr. Bul. 129, 16 pp., illus. 1914.

Palmer, R. C., Yields From the Destructive Distillation of Certain Hardwoods. Second progress report. U. S. Dept. Agr. Bul. 508, 8 pp., illus. 1917.

The results here reported are of most value when compared with laboratory distillations of species whose yields in commercial practice are well known. Laboratory methods are not directly comparable with commercial conditions, and the calculated yields per cord from laboratory distillations on 100 or 200 pounds of wood are frequently much higher than the yields from distilling several thousand pounds in a commercial plant.

TABLE 6.—*Yields of alcohol and acetic acid in percentages of oven-dry weight of material*

Species	Acetic acid	Wood alcohol (100 per cent)
	Per cent	*Per cent*
Red alder	4.60	1.91
Beech	5.87	1.87
Sweet birch	6.80	1.50
Sugar maple	5.26	1.93

TABLE 7.—*Yields of commercial alcohol and acetate per cord of air-dry wood*

Species	Weight per cord (15 per cent moisture)	Wood alcohol (82 per cent)	Acetate of lime (80 per cent)
	Pounds	*Gallons*	*Pounds*
Red alder	2,550	7.6	168
Beech	3,785	11.4	318
Sweet birch	3,600	8.6	351
Sugar maple	3,875	11.7	293

It will be noted that the acetic-acid yield of red alder, expressed in percentage of oven-dry weight of wood, is considerably lower than any of the other three commercial species, and that the alcohol yield is practically the same as sugar maple and beech and higher than sweet birch.

On the basis of the cord, the comparison is not so favorable, for the reason that red alder is comparatively light in weight and the wood substance in a cord is therefore much less than for the standard distillation woods. The alcohol yield on this basis is lower than that of sweet birch, although birch is the poorest of the three standard species for alcohol production. In yields of acetate of lime red alder makes an even poorer showing, giving only a little over half the average yield of the eastern species.

The yields of alcohol obtained in the laboratory retort are very nearly the same as those obtained in commercial practice. Acetate of lime yields in the laboratory, however, are about 60 per cent greater than commercial yields. The commercial yield of red alder would, therefore, be about 105 pounds per cord. Commercial plants in the East obtain 160 to 210 pounds of acetate of lime per cord, depending on the species and the efficiency of the process. The low yields given by red alder indicate that it can not be used for distillation in direct competition with eastern hardwoods.

Furthermore, the destructive distillation of hardwood for the manufacture of charcoal, wood alcohol, and acetate of lime is a highly technical industry requiring rather expensive equipment. Raw material sufficient to insure 15 to 20 years of life to a plant with a daily capacity of at least 40 cords is an essential, and it must not be scattered over too wide an area. Although there is a fairly satisfactory supply of red alder, the wood delivered at a distillation plant would probably cost more than the raw material utilized by plants in the Middle West and East. Together with lower yields, this makes successful competition with eastern distillation woods all the more unlikely.

In the local markets charcoal is about the only product of the distillation process that could be sold to advantage. The possibilities for creating a domestic demand for charcoal are apparently good. With the development of metallurgical processes another large market for charcoal may be created. As it is difficult to ship charcoal for long distances, the market would of necessity be local. Practically no acetate of lime is used on the coast at present, and the consumption of wood alcohol approximates the output of a single good-sized wood distillation plant. The largest opportunity for marketing the chemical products seems to lie in the export trade.

CHARCOAL

The sole powder-manufacturing concern in the Pacific Northwest region uses alder in the production of charcoal, preferring it to softwoods. This concern uses both slabs and bolts, in all about 1,000 cords. One cord of alder will yield from 650 to 700 pounds of charcoal. Otherwise, alder is little used in the production of charcoal.

FUEL

Except as a relatively small amount results from land clearing, practically no alder is used for fuel. Douglas fir, a better and more abundant wood, or the other hardwoods of the region are preferred. Alder has a fuel value of about 80 per cent of that of Douglas fir, 70 per cent of white ash, and 60 per cent of white oak.

The packing industry of the Pacific Northwest is using some alder sawdust for smoking meats, for which it has proved satisfactory.

SECONDARY INDUSTRIES

Table 5 shows that the largest demand for alder on the part of secondary industries, is made by the furniture industry, which used in 1923 slightly less than 72 per cent of the cut. Next in order is the chair industry which used 18 per cent. Four per cent is used for woodenware and novelties, and the remainder for paper plugs, fixtures, brushes, dairymen's supplies, laundry appliances, truck bodies, and miscellaneous articles.

This table shows also that the demand for alder has shifted somewhat in recent years; that in some industries the demand has shrunk considerably or entirely ceased, while in others it has greatly increased. This condition is not due to the properties of the wood but rather to the increasing demand for alder, which has tended to force certain industries to turn to the more plentiful supply of softwoods. For example, in past years relatively large quantities of alder were used by the general millwork factories, whereas the amount so used at present is negligible. A swing from enamel to natural finish might bring this industry again into the alder market.

TABLE 8.—*Woods used by furniture industry of Oregon and Washington, 1923*

Kinds of wood	Quantity used				Price [1]	Source of supply	
	Washington	Oregon	Total			Oregon and Washington	Other States
	Bd. ft.	*Bd. ft.*	*Bd. ft.*	*Per cent*		*Bd. ft.*	*Bd. ft.*
Red alder	4, 010, 000	5, 643, 000	9, 653, 000	48	$33. 08	9, 653, 000	
Douglas fir	3, 686, 000	2, 646, 000	6, 332, 000	31	15. 91	6, 352, 000	
Big-leaf maple	763, 000	816, 000	1, 579, 000	8	35. 17	1, 579, 000	
Sitka spruce (Picea sitchensis)	495, 000	107, 000	602, 000	3	44. 40	602, 000	
Western yellow pine (Pinus ponderosa)	519, 000		519, 000	3	38. 07	519, 000	
Western hemlock	270, 000	137, 000	407, 000	2	36. 85	407, 000	
Eastern oak	208, 000	70, 000	278, 000	1	96. 26		278, 000
Oregon ash	80, 000	160, 000	240, 000	1	36. 11	240, 000	
Western red cedar (Thuja plicata)	173, 000		173, 000	(2)	26. 30	173, 000	
Western birch	160, 000		160, 000	(2)	69. 47	160, 000	
Tanguile (Shorea polysperma), red lauaan (S. negrosensis), and almon (S. eximia) [3]	58, 500	48, 000	106, 500	(2)	176. 41		106, 500
Red gum	105, 000		105, 000	(2)	106. 47		105, 000
Black walnut (Juglans nigra)	41, 600	13, 000	54, 600	(2)	162. 81		54, 600
Black cottonwood		40, 000	40, 000	(2)	19. 00	40, 000	
Japanese oak (Quercus daimio)	30, 000		30, 000	(2)	120. 00		30, 000
Western white pine	20, 000		20, 000	(2)	30. 00	20, 000	
Red cedar (Juniperus virginiana)	15, 000		15, 000	(2)	110. 00		15, 000
Mahogany (Swietenia sps.)	1, 000	6, 000	7, 000	(2)	331. 43		7, 000
Average					31. 30		
Total	10, 635, 100	9, 686, 000	20, 321, 100	100		19, 725, 000	596, 100

[1] Average price per thousand board feet, f. o. b. factory.

[2] Less than 1 per cent.

[3] "Philippine mahogany" is a trade name applied to these three woods. The name mahogany should, in the opinion of the Forest Service, be confined to the genus *Swietenia*.

FURNITURE

Each year the furniture industry of the Pacific Northwest is becoming increasingly important not only in the quantity of material used but also in the value of the products manufactured. In 1923 the total quantity of hard and soft wood consumed by the industry in Oregon and Washington amounted in round numbers to 20,322,000 board feet, with a total value delivered at the plants of $636,000. It is estimated that the furniture industry of these two States, not including factories engaged in chair manufacture exclusively, in that year produced articles valued at $9,500,000, gave employment to 2,500 persons, and had an investment of $6,450,000 in land, buildings, and equipment.

The relative importance to the furniture industry of the 9,653,000 board feet of alder consumed in 1923 is shown by Table 8. The combined consumption of other local hardwoods—big-leaf maple, Oregon ash, western birch, and black cottonwood—amounted to 2,019,000 board feet; that of imported hardwoods to only 581,100 board feet.

Of the total quantity of red alder consumed by the furniture industry proper here classified, not over 5 per cent is used in the manufacture of chairs. Furniture includes some overstuffed chairs, but mostly as part of furniture sets. The production of chairs is a more specialized industry, and for this reason chairs are dealt with under a separate heading.

Red alder is used to a large extent for turned and other exposed parts in all classes of furniture. Its uniform texture and workableness especially suit it for such purposes. Fairly hard and not "wooling up," it polishes well. It takes and hold screws and nails satisfactorily and is relatively easy to glue. All the common kinds of glues, such as animal, casein, and vegetable, can be used successfully with alder, and no difficulty is encountered in making joints as strong in most respects as the wood itself. It compares favorably in gluing properties with yellow poplar, basswood, and red gum.

Alder is used extensively for enameled furniture, its uniform texture being well adapted to take paint, and under ordinary conditions to hold it without cracking. The wood is also frequently finished to imitate black walnut or mahogany.

Much of the alder used for drawer sides, bottoms, and ends consists of three-ply panels. An increasing quantity also is being built up into five-ply panels for high-grade furniture, the alder serving as core and cross bands for high-grade walnut and mahogany veneers.

As a core stock red alder appears to be surpassed by none of the woods now used for this purpose, possessing all the properties essential to this use. As indicated by Table 1, red alder is of low specific gravity and shows but a relatively slight tendency to shrink or swell, a quality most desired in a core stock. Furthermore, the growth rings are not inclined to shrink and swell, with the result that stock made from alder has no objectionable grain markings. The wood has excellent gluing properties, stays flat, and keeps its place under changing moisture conditions. It does not bend easily however, and is not entirely suitable for curved surfaces.

For the purpose of indicating particular uses of alder, the furniture industry may be divided into four general classes, based on the type of furniture manufactured: (1) Combination walnut or mahogany, (2) oak, (3) enameled, and (4) upholstered or overstuffed.

(1) Combination walnut or mahogany furniture includes various kinds of parlor, dining-room, and bedroom furniture, such as dining-room and library tables, table pedestals, piano benches, chairs, buffets, dressers, dressing tables, chiffoniers, wardrobes, sideboards, china cabinets, and desks. In these articles red alder is used for panels, more particularly the core and crossbands; for turned parts, such as legs and stretchers of tables and chairs; for chair and table rails; table slides; drawer bottoms, sides, and ends; mirror frames; and for hidden parts.

(2) Oak furniture includes house, office, college, and library furnishings. In this class alder is used for panel cores, also for drawer sides, bottoms, and ends.

(3) Enameled furniture includes bedroom, nursery, and kitchen furnishings, such as dressers, dressing tables, commodes, chiffoniers, breakfast tables, cabinets, cribs, and chairs, such as high chairs, nursery chairs, dressing chairs, breakfast chairs, and bedroom chairs. Except where special strength is required, alder is used in all parts of such furniture. It is used in solid form for table and dresser tops, and as a core stock in high-grade tops.

(4) Upholstered furniture includes davenports, davenport beds, and overstuffed chairs. Here the use of alder is confined to the legs and parts of the framework requiring but moderate strength.

Of the 9,653,000 board feet of alder used by the furniture industry in 1923, 8,228,000 feet were purchased in the form of rough lumber, mostly in the green condition. The remainder was produced at the furniture factories from purchased logs.

CHAIRS

In point of quantity of alder used in Oregon and Washington, the chair industry ranks next to the furniture industry. In 1923 the industry in these two States used 2,410,000 feet of alder, or about 18 per cent of the total cut, in addition to the 480,000 feet consumed by the furniture industry in the production of chairs.

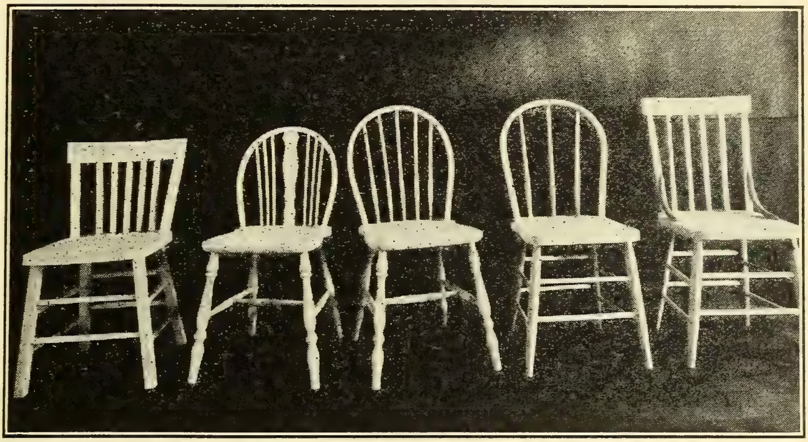

FIG. 6.—CHEAP-GRADE ALDER CHAIRS

The bows, pillars, and bent-top slats are made of oak

The total consumption of all woods by the chair industry of Oregon and Washington amounted in 1923 to 6,379,000 board feet, of which 5,804,000 feet consisted of local woods. Big-leaf maple leads the list of home-grown woods, the 2,661,000 feet of this wood exceeding the demand for red alder by 251,000 feet. Consumption of black cottonwood amounted to 438,000 feet, Oregon ash 125,000 feet, Oregon white oak 95,000 feet, western birch 55,000 feet, and Douglas fir 20,000 feet. Of the 575,000 feet of imported woods used eastern oaks made up 490,000 feet.

The chair industry uses alder chiefly in the production of what might be considered as standard goods, but of a cheap to medium-grade variety. A relatively small quantity is used in the framework of overstuffed chairs, which includes all grades from the poorest to the best. Most of the alder is used in the manufacture of the cheaper grades of solid-wood chairs, as kitchen, dining-room, and office chairs, rocking-chairs, and stools; also chair stock, including bottoms, legs, and stretchers. All parts of these chairs are made of alder except the bow backs, bent-top slats, and runners. The bow backs, pillars, and bent-top slats are made of either red (eastern) oak (*Quercus borealis maxima*) or Oregon white oak, the runners usually of big-leaf (western) maple. Figures 6 and 7 show various designs of cheap chairs and stools made largely of alder.

The industry also uses alder in the manufacture of medium-grade chairs, mostly of the slip-seat diner variety. The legs, stretchers, and side and front rails of these chairs, which are made in various period styles and finished to imitate black walnut, are made solely of alder. In medium-grade rocking-chairs and ordinary diners the extent to which alder is used depends on the finish. If the chairs are finished in walnut or mahogany, the rails, stretchers, and posts are often of alder; otherwise alder is used only as a core stock in the seats, side rails, and top slats.

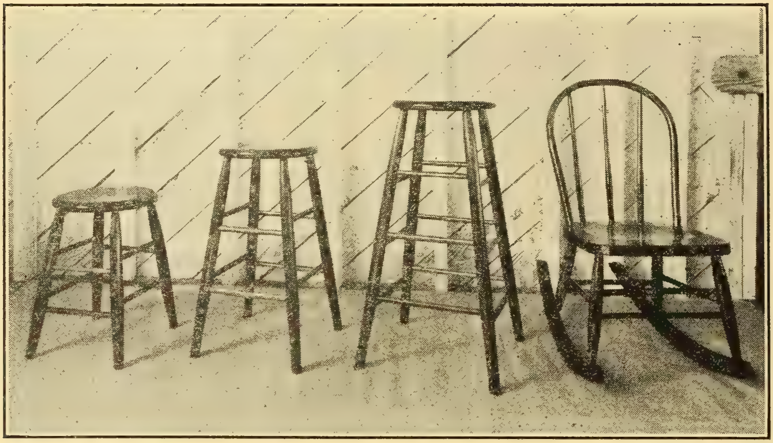

FIG. 7.—ALDER STOOLS AND ROCKING-CHAIR

The rockers are made of maple

The chair manufacturers purchase 95 per cent of their alder supply in the form of logs, which by means of simple equipment, consisting for the most part of a circular saw, carriage, and sawdust conveyor, are converted into 1 to 3-inch lumber. The thick stock is used in chair bottoms.

WOODENWARE AND NOVELTIES

A number of separate and distinct uses for alder are included under "Woodenware and novelties." The ordinary household articles known as woodenware and the more ornamental article known as a novelty are not always easy to classify. Then, too, establishments that make woodenware are frequently manufacturers of novelties as well as other classes of articles, consuming similar stock and reporting their raw material together.

In 1923 about 550,000 feet of alder was consumed in the production of floor lamps, candle sticks, smoke stands, table lamps, pedestals, umbrella stands, taborettes, ferneries, sewing cabinets, hat racks, telephone stands and stools, foot stools, towel racks, tent toggles, and ladder rungs. In these articles alder is used for turned or other exposed parts in much the same way and for the same purpose as in the case of furniture and chairs.

Alder is used but slightly for woodenware. It would seem, however, that it is well suited for certain articles of this class, including bread boards, cloth boards, lap boards, cutting boards, scoops, rolling pins, etc. It is light in weight and odorless and makes a good appearance.

PAPER PLUGS

Because of the ease with which it can be turned and bored, red alder has proved very satisfactory for paper plugs. Paper manufacturers insert the plugs in the ends of rolls of paper, so that in storage or transportation the rolls will not lose their shape.

FIXTURES

Largely because of its finishing qualities, red alder is a desirable wood for fixtures. Where free from excessive wear, as in wall panels, wall cases, wall racks, shelves, and booths, it is used in place of red gum and sweet birch. As in furniture and chairs, it is finished in walnut and mahogany or enameled.

HANDLES

In past years alder was used extensively in the production of long handles, such as broom, mop, and window-brush handles. At the present time, however, these articles in the Pacific Northwest are made almost entirely of Douglas fir, a stronger and much more abundant wood. In addition to the 40,000 board feet of alder used in 1923 in the production of short handles and the backs of cheap brushes, about 15,000 feet were used in the manufacture of file and other cheap tool handles, also in the manufacture of basket, kettle, and pot grips.

DAIRYMEN'S AND APIARISTS' SUPPLIES

Under this heading are included beehives, bee supplies, butter ladles, butter molds, butter tubs and pails, dairy supplies, egg carriers, and the like. Of these, butter molds only are now made of alder.

There is a possibility that other products of this class could be successfully manufactured from alder; for example, inner honey boxes or sections. Basswood is a favorite wood for this article at present. Alder, although slightly darker, should give just as good results. It works as easily, machines as smoothly, and is stronger than basswood. Furthermore, it is light in weight and does not warp. It is said that the burning of sulphur in the dry kiln just before the end of the drying period will bleach alder, giving it the white appearance preferred for honey sections.

LAUNDRY APPLIANCES

The 10,000 feet of alder under this classification is used annually in the production of one-piece clothespins and clothesline props. On account of its good appearance and because it works easily to a smooth surface and does not warp or split in use, it is well suited also for the manufacture of ironing boards.

MOTOR VEHICLES

So far as could be determined only 3,000 board feet of alder was used in the construction of auto-bus and truck bodies in 1923, for those parts of the framework where no strain occurs.

GENERAL MILLWORK

For all interior work, except that subjected to excessive wear, red alder is an excellent wood. As it is satisfactory for furniture, chairs, and fixtures, it would be surprising if this were not true. The only limiting factor is supply. In 1923 little or no alder was used for this purpose, although earlier statistics show that the general millwork industry used alder in rather large quantities.

MISCELLANEOUS AND POTENTIAL USES

Kitchen cabinets.—Alder used in the production of kitchen cabinets and tables is reported under the heading " furniture." For these articles it is an excellent wood, except that it may not be entirely satisfactory for unfinished table tops.

Picture frames and moldings.—As with kitchen cabinets, any alder that may have been used in the production of mirror frames, mirror backs, picture molding, and picture backs is included under " furniture." Light in weight, even in texture, working easily, and taking an excellent mahogany, walnut, or enamel finish, it is an excellent wood for such uses.

Penholders.—Red alder has been used to a slight extent for penholders, proving entirely satisfactory.

Tailor equipment.—A small quantity of alder is used in the production of tailors' equipment, such as pressing boards, steam boards, and coat hangers. Seventeen different styles of coat hangers are made from alder by one firm. The ease with which it can be worked to a smooth surface and its freedom from warping and splitting recommend it for this use.

Plumbers' woodwork.—Red alder is well adapted for toilet and medicine cases or cabinets, towel cabinets, and racks, and other cabinet work for toilets, which may be finished to imitate the more expensive hardwoods, or enameled to match the tile work of the room. Only a small quantity is used for this purpose at present.

Printing materials.—Red alder is said to be suitable for bases of electrotypes and cuts. Although not so hard as black cherry, birch, and hickory, woods generally used for this purpose, it has the requisite qualities of being free from warping and capable of holding nails without splitting.

Shade and map rollers.—Red alder would serve well for curtain poles and window-shade and map rollers. It is especially suitable for curtain poles, because it works easily and because of the ease and permanence with which it takes paint or stain.

Pulleys.—Because it is light in weight, has good gluing qualities, holds nails well without splitting, and does not shrink, swell, or warp perceptibly, red alder has been used for the rims of wooden pulleys. It is well adapted for use in the construction of buffer wheels, such as are used for polishing metals, glass, etc., because it is fine-grained and holds the polishing materials well.

Spools, reels, and bobbins.—The properties of alder seemingly fit it for spools, reels, bobbins, and spindles, and actual tests suggest that it will satisfactorily serve these purposes.

Toys.—That practically no alder is used in the manufacture of toys is due to the fact that there is no toy industry in the Pacific northwest or near the source of alder supply. Its good working, staying, and finishing qualities recommend it for this use. It is somewhat stronger than basswood, and in every other way the equal of this principal toy wood in the United States, both for toys made entirely of wood and for wooden parts of metal toys. Without doubt red alder is admirably suited, entirely or in part, for all classes of toys not requiring exceptional strength, such as the following: Wagons, buggies, automobiles, wheelbarrows, hobbyhorses, toy animals of various kinds, toy pianos, doll houses, toy furniture, cannon, gun stocks, blocks, dominoes, checkers, puzzles and wooden dolls.

METHODS OF LUMBERING

Because of the scattered character of the stand, with consequent small logging units, and uncertainties in demand and price, the logging and milling of alder has been conducted on a small scale, and in the main has not proved a steady or lucrative business. As would be expected under such conditions, the industry is marked by an absence of specialization and high-class management, such as are found in the softwood industry of the region. Operators usually are men of small means. Not infrequently they are relatively inexperienced. Manufacturing equipment is simple and often seemingly inadequate.

LOGGING

The joblike character of the industry is especially noticeable in logging. Many of the operators are ranchers who engage intermittently in the logging of alder as a side line during the slack season. Independent loggers of this general character usually furnish the logs for the more distant alder mills at a price ranging from $15 to $22 per thousand feet. The cost of felling, bucking, and moving the logs to a railroad, paved highway, or towable stream, runs from $6 to $10 per thousand. Only in a few cases do mill owners engage in logging, although, in order to provide a regular and satisfactory supply of logs they sometimes finance logging operators. Where mill operators own stumpage near the mill, the usual practice is to contract the logging, generally at $6 per thousand feet laid down at the mill.

Alder is logged with horses; the small size of the timber and the small stand per acre make steam logging impractical. A crew usually consists of three to five men, any one of whom may work at the different steps in the operation. The timber is felled with either saw or ax and ground-skidded to the mill or loading landing, if the distance does not exceed three-eighths of a mile. For greater distances wagons or auto trucks are resorted to, and the skidding distance is not ordinarily more than 400 feet. The wagon or auto haul to the landing or possibly to the mill seldom exceeds 1 mile. Most of the mills, of course, are located long distances from the landings. The cost of moving the logs from the landings to the mills is dealt with under the heading "Transportation."

Because of differences in the volume per acre, size of timber, character of ground, and hauling distances, and because reliable cost records are not available, little more than approximations of logging costs can be given. For low and high costs per thousand feet these are:

	Low	High
Felling and bucking	$2.50	$3.00
Skidding, not to exceed three-eighths of a mile	1.50	4.00
Hauling, not to exceed 1 mile	2.00	3.50
	6.00	10.50

Utilization in the woods is fairly close. Most of the alder cut averages from 14 to 22 inches in diameter at the stump, but 10-inch trees are taken. Tops are utilized up to a 6-inch diameter. The logs are usually cut in 8, 10, and 12-foot lengths, largely 8-foot, with no allowance for trimming. It takes from 15 to 30 logs to make a thousand feet log scale.

MILLING

Most of the alder lumber is cut by small mills of the portable type, with a daily capacity of from 1,500 to 4,000 board feet. Bolting or short-log machines are occasionally used. Some of these mills are located in the timber; others are located centrally in alder regions, but at some distance from timber, transporting their log supply by railroad, water, or auto truck; a few are operated by secondary wood-using factories, at a considerable distance from the timber.

The usual equipment of an alder mill consists of a carriage with head blocks and set works, track, saw, power-transmission facilities, and in some cases a sawdust conveyor. A few of the mills are provided with edgers. The saws, 42 to 50 inches in diameter and of the inserted-tooth type, cut a four-sixteenth-inch to five-sixteenth-inch kerf. Most of the carriages will accommodate 24-foot logs, but the logs as a rule no not exceed 12 feet in length. Logs for bolter mills seldom exceed 10 feet. Dead rolls may or may not be used for carrying the lumber from the saw.

The power for mills located near the timber is usually supplied by a steam or gasoline tractor. Where the supply of timber warrants, a stationary engine and boiler are sometimes used. Some of these mills are operated with a 7 or 8 horsepower engine, an insufficient amount of power. They should have from 12 to 20 horsepower. Mills located in or near settlements, and so at points more distant from the timber, as well as mills operated in connection with wood-using factories, use gasoline or steam engines, or electricity.

Figure 8 shows a typical portable mill with tractor, located in the timber. A layout of this character, purchased second hand, costs from $1,200 to $1,700; purchased new, from $2,000 to $2,500. Centrally located mills, because of better construction and the inclusion sometimes of an edger and cut-off saw, cost from $2,500 to $4,000, purchased new.

The essential equipment for an alder mill purchased new, will cost approximately $2,000. A mill so equipped will have a capacity of 2,000 to 7,000 feet per 8-hour shift, depending largely on the amount of power available; 2,000 to 3,000 feet with a 6 to 8 horsepower engine, 6,000 to 7,000 feet with a 20 to 25 horsepower engine.

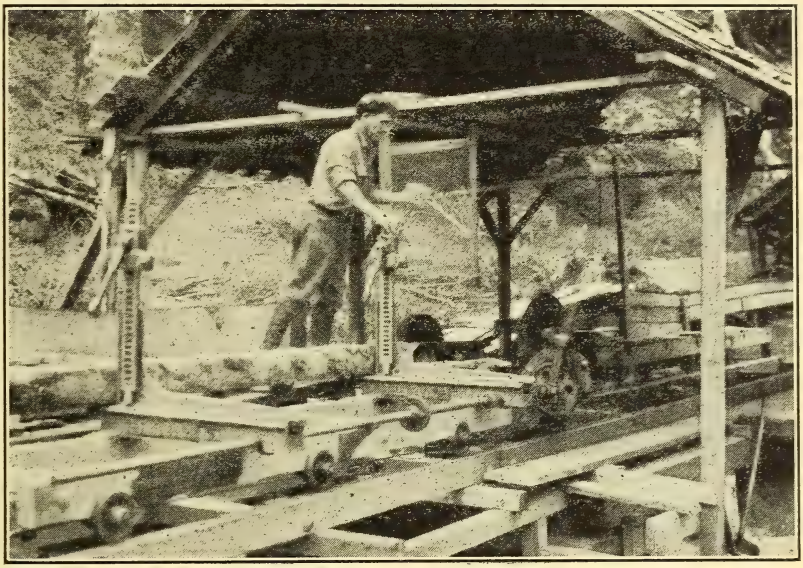

FIG. 8—A TYPICAL ALDER SAWMILL

The power is supplied by a gasoline tractor housed in the shed shown in the background

A 26-tooth, 8-gauge, 50-inch saw is provided. Smaller saws, though such are used, are not recommended. A list of equipment, with costs figured on 1924 quotations, f. o. b. Portland, Oreg., is as follows:

Sawmill (husk and carriage)	$550
Sawdust conveyor, 25-foot	60
Circular saw, 50-inch, inserted-tooth, 8-gauge	133
Tractor, gasoline, 20-horsepower	1,075
Belting, tools, etc	100
Total	1,918

The crew of the usual operation varies from two to five men, depending largely on the character of the equipment. Where there is only a head rig, the crew consists of a sawyer, offbearer, and sometimes a general roustabout. The use of an edger and cut-off saw requires two additional men.

Men engaged in the sawing of alder are for the most part relatively inexperienced, especially among so-called independent operators. This, together with the character of the equipment, results in different operating costs. In some mills the cost will run as high as $10 per thousand feet; in others, where round-edged lumber is sawed, as low as $6 per thousand.

Alder logs are generally sawed into 8 to 12 foot lengths. Lumber from longer logs has a tendency to buckle in sawing, resulting in uneven thicknesses. Usually the log is turned on the carriage until, through slabbing or sawing, it has been reduced to a square; it is then sawed through and through into square-edged boards 4/4 to 12/4 inches in thickness, mostly 4/4 inch. If the mill is not equipped with an edger, the round-edged boards are edged with the head saw.

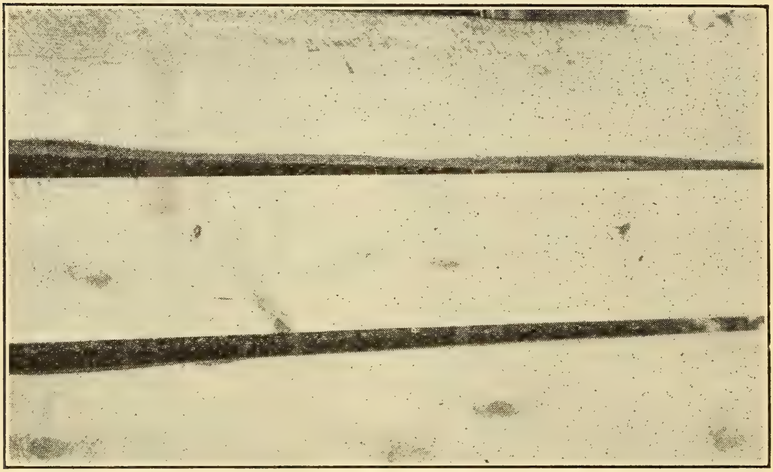

FIG. 9.—TYPICAL ALDER BOARDS

The top board is practically clear. The others show characteristic defects

In mills operated in connection with secondary wood-using factories, the log is usually converted into lumber by removing a thin slab from one side, and then sawing the log through and through into round-edged lumber, ready for the cut-up plant. The use of round-edge lumber increases the percentage of the log utilized by saving a portion that would have been wasted had the boards been edged and is of especial merit in chair manufacture.

Because of the small size of the timber and the manner of its growth, alder yields but a small percentage of " clear " lumber, or about 5 per cent in the case of a good stand. Defects include black or rotten knots, and occasionally rotten streaks. Not infrequently the boards from butt logs will split lengthwise for several feet, especially if swell butted. Figure 9 shows characteristic defects, also a nearly clear board.

Alder is most often scaled by the Scribner rule which, because of its underestimation of small-sized material, results in a considerable overrun. A mill-scale study conducted at a small portable mill of average efficiency and operating in medium-sized timber showed the overrun to be 20 per cent. Reports indicate that an overrun of 25 to 30 per cent by the Scribner rule is not unusual.

TRANSPORTATION

Alder in the form of logs or lumber must be transported rather long distances to the consuming factories, located largely in Seattle, Tacoma, and Portland. As a result, transportation costs, which as already defined do not include the first mile in the woods, represent a large percentage of the total cost of the lumber to the consumer. About 80 per cent of the logs produced are subject to transportation charges as such, 20 per cent of these being transported by water, 35 per cent by auto truck, and 45 per cent by rail. Of the lumber produced by the independent mills, which represents 70 per cent of the total lumber cut, about 95 per cent is transported by common-carrier railroads and 5 per cent by auto trucks. From this it will be seen that more than 50 per cent of the alder consumed is first transported as logs and then as lumber before it reaches the factory in form for use.

WATER

Water transportation is limited to the towing of rafts of 20,000 to 40,000 board feet each on the Columbia River and Puget Sound. No definite towage rates for alder have been established by the towing companies, doubtless because of the small quantity moved by water, the small size of the rafts, and the fact that alder rafts are usually made up at points off the regular towing routes. As a result, the rates vary considerably, but usually are considerably in excess of those quoted for large rafts of softwoods. The cost averages from $2 to $4 per thousand feet.

Alder logs, riding very low in the water, tend to duck under the boom sticks and so get away. To prevent this the logs are bound together in tiers by means of cables passed through eye bolts driven in logs, with the tiers in turn bound to the boom sticks.

AUTO TRUCKS

Of the alder logs transported to mills outside of the woods and more than 1 mile from the timber, something less than 35 per cent go by auto truck. Judging from present practice, it is not ordinarily practical to move logs by this method for distances greater than 7 or 8 miles. Many of the operators own trucks, some hire them by the day, and others contract the work at a stipulated amount for each thousand feet. The cost of truck transportation averages $3 to $6 a thousand board feet, depending for the most part on the distance.

Only a small quantity of alder lumber is transported by auto trucks. As in the case of logs the cost varies considerably, even when the distance and character of road are practically the same. For distances up to 80 miles, the cost ranges from $3 to $10 a thousand feet.

RAILROADS

Alder is transported chiefly by common-carrier railroads, in the form of logs to the centrally located sawmills and wood-using factories, and in the form of lumber from both the woods and centrally located sawmills to the wood-using factories.

WEIGHT OF LOGS AND LUMBER

In Washington and Oregon, with one exception, freight charges on both logs and lumber are based on the weight of the shipment. Alder logs weigh 7,000 to 7,500 pounds per thousand feet, log scale; green lumber, 4,000 to 4,500 pounds per thousand; kiln-dried lumber, with a moisture content of about 8 per cent, 2,250 to 2,500 pounds. The small size of the timber precludes a large log scale per car, a load usually averaging 7,000 to 8,000 board feet.

LOG RATES

By far the largest portion of the logs transported by rail originates in Washington. In this State the logs are usually cut in 8-foot lengths. This is a very satisfactory length from the standpoint of lumber manufacture. Moreover, 8-foot logs take the bolt rate. The Northern Pacific, Great Northern, and Chicago, Milwaukee & St. Paul Railway companies have established the intrastate distance rates on bolt-length logs given in Table 9. These rates apply only to carload lots of a minimum weight of 50,000 pounds. For rates to Portland, Oreg., from points in Washington, 3 cents per 100 pounds should be added to the log-bolt rates established for Washington.

The Portland Electric Power Co. hauls alder logs on the basis of carload lots. With this exception, the railroads of Oregon quote log rates on a weight basis, irrespective of log lengths. Table 10 shows the log rates quoted between several Oregon points.

LUMBER RATES

Rates on alder lumber, generally quoted on a mileage basis, are established only as requests are made. Table 11 gives some of the established rates in Oregon and Washington.

TABLE 9.—*Bolt rates, or distance freight rates on alder logs not exceeding 8 feet in length, Washington, 1925*

Distance	Rate per 100 pounds	Distance	Rate per 100 pounds
	Cents		*Cents*
Not over 5 miles	[1] 2	Over 90 miles and not over 110 miles	5
Over 5 miles and not over 30 miles	[1] 3	Over 110 miles and not over 140 miles	5½
Over 30 miles and not over 50 miles	3½	Over 140 miles and not over 160 miles	6
Over 50 miles and not over 70 miles	4	Over 160 miles and not over 180 miles	6½
Over 70 miles and not over 90 miles	4½	Over 180 miles and not over 200 miles	7

[1] Minimum charge of $15.50 per car.

TABLE 10.—*Freight rates on alder logs delivered to Portland, Oreg., 1925*

Railroad	Shipping point	Distance	Rate per 100 pounds
		Miles	*Cents*
Spokane, Portland & Seattle	Astoria, Oreg	100	10½
Do	Clatskanie, Oreg	62	8
Do	Vernonia, Oreg	50	10
Do	Banks, Oreg	28	7
Do	Wilkesboro, Oreg	26	6½
Do	Vadis, Oreg	23	6½
Do	North Plains, Oreg	22	6½
Southern Pacific	Black Rock, Oreg	79	[1] 7½
Do	Dayton, Oreg	35	7
Do	Banks, Oreg	40	7
Do	Elk City, Oreg	142	[1] 10½
Do	Mapleton, Oreg	180	20
Do	New Era, Oreg	21	6
Portland Electric Power Co	Bull Run, Oreg	30	[2] $20.90
Do	Boring, Oreg	21	[2] 16.50
Do	Troutdale, Oreg	20	[2] 16.50
Do	Linneman, Oreg	14	[2] 13.20

[1] Rate on 8-foot logs.

[2] Rates quoted on carload lots only. Load not to exceed rated capacity of car, usually between 7,000 and 8,000 board feet.

TABLE 11.—*Freight rates on alder lumber, Oregon and Washington, 1925*

Railroad	Shipping point	Delivery point	Distance	Rate per 100 pounds
			Miles	*Cents*
Spokane, Portland & Seattle	Astoria, Oreg	Portland, Oreg	100	10½
Do	Clatskanie, Oreg	do	62	8½
Southern Pacific	Toledo, Oreg	do	155	17
Do	Siltcoss, Oreg	do	200	20
Do	Willamina, Oreg	do	65	11½
Northern Pacific	Kent, Wash	do	170	14½
Do	Seattle, Wash	do	186	15½
Do	Auburn, Wash	Tacoma, Wash	18	5
Great Northern	Monroe, Wash	Seattle, Wash	49	7
Do	do	Tacoma, Wash	89	9½
Do	do	Portland, Oreg	232	23
Do	Everett, Wash	Seattle, Wash	33	7
Do	do	Tacoma, Wash	73	9
Chicago, Milwaukee & St. Paul	Morton, Wash	do	70	6½

STUMPAGE, LOG, AND LUMBER VALUES

To be marketable under present market conditions red alder stumpage must be located within a mile or two of transportation facilities, such as a good road, towable water, or railroad; and then it is worth about $2 per thousand feet. Good-sized and well-located stumpage has sold for as high as $3.50 per thousand feet. Small units of scattered stumpage not infrequently sell for as little as $0.50 per thousand feet.

Except as a small amount of specially selected logs are used for veneer manufacture, alder logs are sold on a camp-run basis. The location of the mills with reference to the timber and transportation facilities largely fixes the price of logs. Table 12 gives average, high, and low prices paid for logs delivered to the different classes of mills. The spread between high and low prices is largely due to differences in the distance between the timber and mills. The sawing of logs at the factories costs $6 to $10 a thousand feet.

Veneer logs, which must be over 12 inches in top diameter and reasonably clear, straight, and sound, sell for about $40 per thousand feet delivered at the mill. Operators manufacturing both lumber and veneer sometimes purchase camp-run logs, from which they are able to select logs suitable for veneer manufacture. Under such conditions they generally pay a premium of $2 per thousand for logs over 18 inches in diameter at the top and otherwise suitable for veneer manufacture.

TABLE 12.—*Camp-run prices of alder logs per thousand feet, delivered to mills, 1923*

Location of mills	Price per 1,000 board feet		
	Average	High	Low
In timber	$8	$10	$6
On tidewater	19	21	16
On highway	17	20	15
On railroad	20	22	18

TABLE 13.—*Green alder lumber prices, 1923*

Delivery point	Price per 1,000 board feet		
	Average	High	Low
Portland	$35	$37	$32
Tacoma	30	35	28
Seattle	30	38	28

Alder lumber is sold "mill run with culls out," culls being considered as lumber so defective as to contain very little material of value. The term "culls" has not been standardized, however, and grading practice varies somewhat. For example, one operator would include as merchantable a 4/4-inch board 4 feet long, from which a 3-inch strip could be cut, while another would cull the whole board.

Prices paid for different thicknesses are substantially the same. Moreover, the moisture content of the stock has no bearing on the price, green lumber selling for just as much as partially air-seasoned stock. Of course, since the price of alder lumber is generally quoted f. o. b. delivery point, the producer who ships by rail actually receives more for partially air-seasoned lumber. Table 13 shows average, low, and high prices paid in 1923 for green alder lumber delivered to the principal consuming centers.

Most users of alder lumber prefer to kiln-dry their own stock. There is, however, a small demand for kiln-dried lumber, mainly from small consumers who can not afford to operate kilns. The average price paid for kiln-dried lumber in Seattle and Tacoma in 1923 was $45 per thousand feet; in Portland, $50 per thousand.

CHARACTERISTICS, GROWTH, AND YIELD OF RED ALDER

Red alder has certain characteristics a study of which will determine how the species can be reproduced most successfully and what treatment is necessary for its best development.

ASSOCIATED SPECIES

Throughout the greater part of its geographical range, red alder occurs in the forest as a comparatively small-sized tree in mixture with a variety of other moisture-loving trees, such as western red cedar, lowland white fir, Sitka spruce, western hemlock, Douglas fir, Oregon ash, Oregon myrtle (*Umbellularia californica*), various species of oak, big-leaf maple, black cottonwood, cascara (*Rhamnus purshiana*), and Pacific dogwood (*Cornus nuttallii*). In some places several of these species are associated, elsewhere but one or two of them. In bottom lands, along water courses, and on well-watered slopes red alder commonly forms practically pure stands.

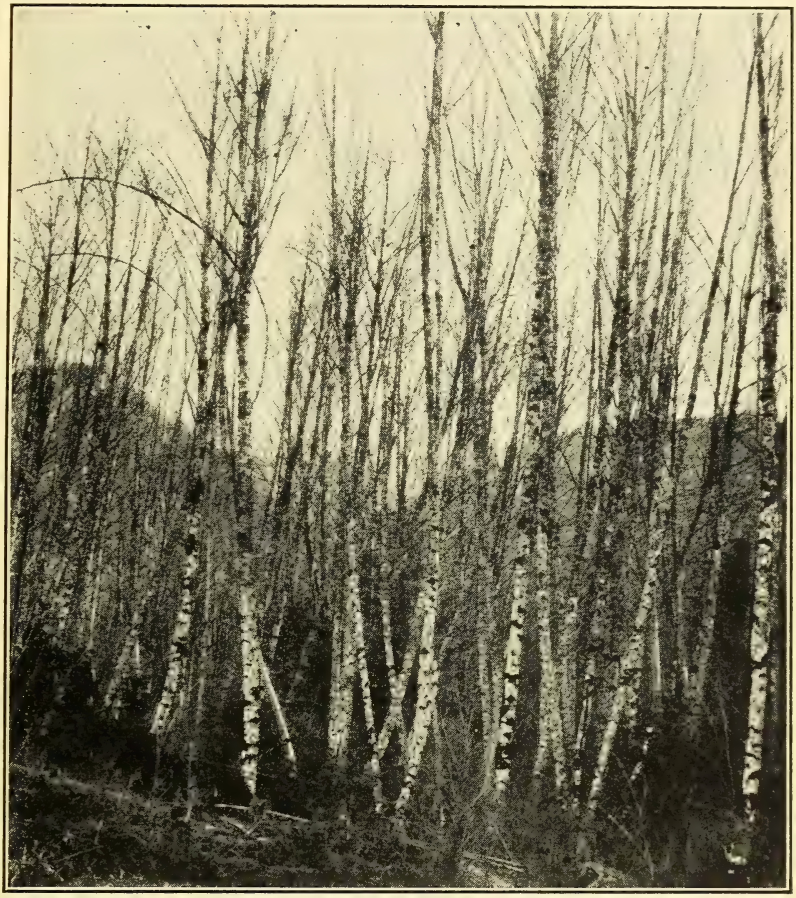

FIG. 10.—A TYPICAL STAND OF ALDER ABOUT 40 YEARS OLD

The trees measure 10 to 17 inches in diameter and 80 to 90 feet in height

On the lower slopes of the coast mountains of Washington and Oregon it usually grows in pure stands of relatively small area, and takes possession of burned-over lands which have been slow to reforest with conifers. Here it tends to give way after maturity to conifers such as Douglas fir, western hemlock, Sitka spruce, and western red cedar, which come up beneath its cover.

SOIL AND CLIMATIC REQUIREMENTS

For its best development as a tree or forest type, red alder demands a deep, fertile, loamy soil, although it will grow in gravel, sand, or clay. Abundant soil moisture is a prime requirement of this species, and it will prosper in very wet ground but not in bottoms subject to overflow.

The climate within the range of its best growth is temperate and humid, with an annual precipitation that averages more than 40 inches, and sometimes reaches 100 inches or more. The growing season is long, and is free from frosts for four or five months. The fact that alder is confined to low elevations indicates that it will not endure severe cold and requires mild temperatures.

LIGHT REQUIREMENTS

Red alder is below the average in its ability to endure shade when compared with its associated broad-leaf trees, with the possible exception of black cottonwood. It never grows in deep shade, nor casts an extremely dense shadow, and usually requires some side light as well as light from above. In mixtures with other species, the tree appears to demand a dominant or codominant position in the crown canopy. The fact that considerable light is needed suggests that the largest yields will be obtained in even-aged stands, where all the trees are about the same height and all receive direct top light (fig. 10).

SUSCEPTIBILITY TO INJURY

Up to the time of its maturity, or at about 50 years of age, red alder is exceptionally free from all sorts of diseases and injuries.

Damage to red alder from forest fires is unusual; in fact, red alder serves to protect adjacent conifer stands from fire damage. The débris which accumulates under alder stands is not ordinarily inflammable. This, together with the dampness of the ground, constitutes a fire guard. Only during seasons of exceptional dryness will fires run in alder stands. The bark, although thin, is sufficiently fire-resistant to protect the tree from light surface fires.

Until mature red alder is relatively free from serious fungous diseases, particularly within its commercial range. A few fungi attack the leaves; and one species deforms the scales of the fertile catkins, but without affecting the fruit itself. A canker disease, which kills young trees and the twigs and branches of older trees, is found occasionally. The most important disease is white heart rot, caused by the false-tinder fungus (*Fomes igniarius* (L.) Gill.). This fungus attacks the wood of both living and dead trees, finally reducing it to a yellowish-white spongy mass. In the aggregate these diseases cause trifling economic loss, if the stands are cut at about 50 years of age or earlier.

Leaf-eating insects, especially caterpillars of various species, occasionally destroy the foliage of alder on considerable areas, but the only effect of this defoliation is to lessen the season's growth. Boring insects sometimes kill individual branches but rarely whole trees.

REPRODUCTION AND DEVELOPMENT

Seed production is moderately abundant, and judging by the readiness with which burns and cut-over areas become restocked with alder, the seed must scatter widely and germinate freely (fig. 11). The seedlings become established readily either on litter or on mineral soil, in partial shade, or in the open. Root sprouts are common, and stump sprouts are not unusual, yet neither can be relied on to stock burned or cut-over areas.

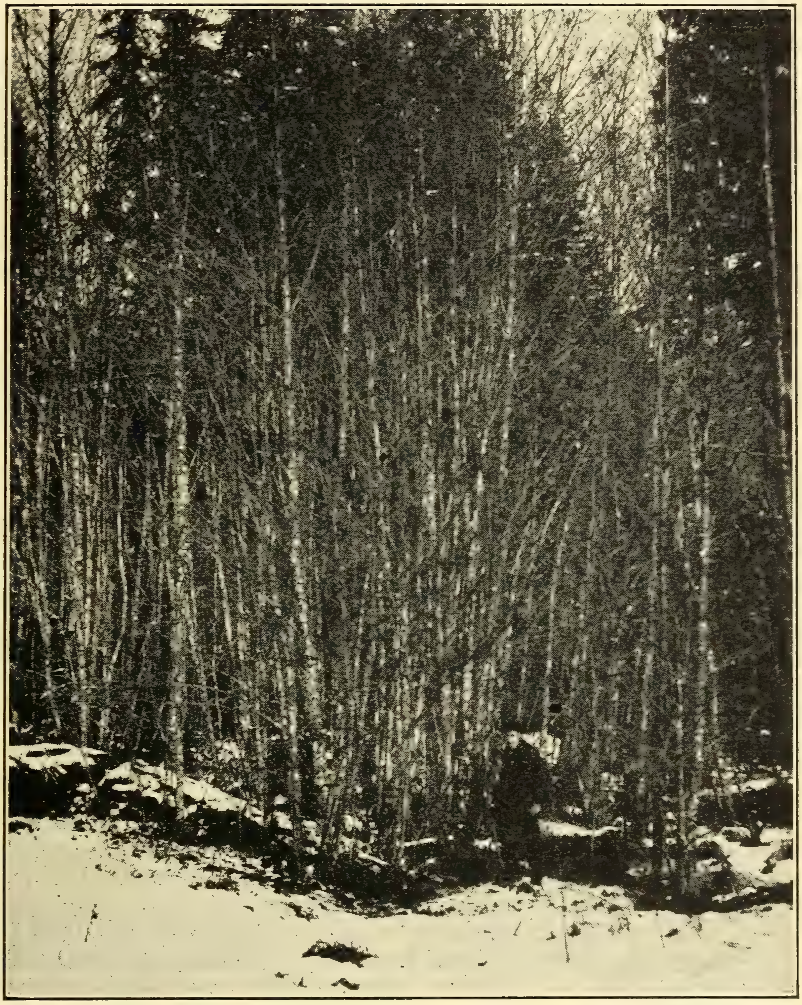

Fig. 11.—A TYPICAL STAND OF ALDER ABOUT 10 YEARS OLD, ON CUT-OVER LAND

Although individual trees growing in the open attain a maximum size of about 120 feet in height and nearly 4 feet in diameter, mature forest trees in the region of best development are usually from 80 to 100 feet high and from 14 to 18 inches in diameter. The bole is straight, giving off rather slim branches which droop in a narrow, long, domelike crown. The thin-barked, smooth-looking, light ashy gray and whitish trunks are clear of branches for at least 20 to 40 feet. The root system, as would be expected from the preference for moist soils, is shallow.

Red alder is a relatively short-lived species. Eighty years is an old age for this tree, and it may be said to be mature at about 50 years. The maximum age recorded thus far is 101 years. In early life it grows very rapidly, more rapidly even than Douglas fir and the associated broad-leaf species. Owing to its early maturity, however, the species which are first surpassed by red alder later outstrip it; in fact, alder stands if left under natural conditions are likely to be replaced altogether by other species.

Table 14 shows the diameter, height, and volume of alder trees at various ages, based on measurements of 115 trees in the Puget Sound region.

TABLE 14.—*Average diameter at breast height, average total height, and average volume of red alder trees of various ages* [1]

Age (years)	Average diameter at breast height	Average total height	Volume		
	Inches	*Feet*	*Board feet*	*Cubic feet*	*Cords* [2]
25	10.2	78.0	75	18	0.20
30	11.0	81.9	92	23	.26
35	11.9	85.8	120	28	.31
40	13.0	89.7	167	34	.38
45	14.5	93.6	240	42	.47
50	16.0	97.5	335	52	.58
55	17.3	101.4	390	63	.70
60	18.5	105.3	430	75	.83

[1] Read from curves. Based on 115 tree measurements, Puget Sound region. Field work conducted by Forest Examiner A. A. Griffin.

[2] Cord assumed to have equivalent of 90 cubic feet.

YIELDS

Table 15 gives in board feet by the Scribner rule and in cubic feet the yield per acre in a number of even-aged red alder stands. The indication is that land cut over to-day and properly managed can be expected to yield 50 years from now not less than 15,000 board feet of saw logs to the acre with possibilities as high as 40,000 feet. The figures are based on measurements of 16 sample plots (13¾ acres) in typical forests in the Puget Sound region of Washington and the Coast Range of Oregon. Most of the plots were located at relatively low altitudes, ranging from sea level to 500 feet. The 80-year-old plots were at an elevation of about 1,800 feet.

Tables 14 and 15 indicate the probability of an average annual growth per acre, on good sites, and after allowing for the loss of a certain number of trees through death, of 300 to 800 board feet up to 50 years.

TABLE 15.—*Growth data for 16 even-aged stands of red alder in western Washington and western Oregon*[1]

Average age (years)	For all alder trees in stand						Alder 8 inch and over				Other species, trees
	Total trees	Base area	Diameter average tree[2]	Height average tree	Volume[3]	Average annual growth	Total trees	Diameter average tree[3]	Volume[3]	Average annual growth	
	No.	*Sq.ft.*	*In.*	*Ft.*	*Cu.ft.*	*Cu.ft.*	*No.*	*In.*	*Bd.ft.*	*Bd.ft.*	*No.*
30	472	140. 0	7. 4	75	6, 304	210. 1	176	9. 1	10. 440	348	12
33	147	149. 9	13. 7	92	5, 355	162. 3	130	14. 9	26. 909	815	0
35	134	124. 3	13. 0	91	4, 348	124. 2	110	14. 2	20, 128	575	0
38	293	104. 8	8. 1	72	2, 888	76. 0	139	10. 0	8, 656	228	37
39	127	129. 5	13. 7	92	4, 373	112. 1	115	14. 2	23, 186	595	0
40	96	82. 3	12. 5	83	2, 711	67. 8	86	13. 1	12, 343	309	39
40	155	98. 4	10. 8	80	2, 954	73. 8	133	11. 6	14, 462	362	24
40	211	142. 5	11. 1	80	4, 202	105. 0	163	12. 2	28, 292	707	41
45	102	115. 3	14. 4	93	4, 234	94. 1	94	14. 9	23, 582	524	134
45	160	120. 7	11. 8	88	4, 452	98. 9	135	12. 6	21, 764	484	62
45	184	122. 3	11. 0	86	4, 236	94. 1	154	11. 8	18, 810	418	40
50	130	162. 8	15. 2	95	6, 191	123. 8	128	15. 2	32, 414	648	6
55	111	131. 5	14. 7	103	5, 746	104. 5	101	15. 3	32, 195	585	42
55	128	111. 5	12. 6	99	4, 986	90. 7	114	13. 2	24, 160	439	166
80	127	128. 1	13. 6	93	4, 563	57. 0	127	13. 6	25, 238	315	63
80	118	126. 1	14. 0	94	4, 778	59. 7	116	14. 1	24, 036	300	54

[1] Field study conducted by Forest Examiners Griffin and Wilcox. Total area of sample plots. 13½ acres. All data presented on a per acre basis.

[2] Diameter at breast height.

[3] The volume in cubic feet includes the contents of the whole stems of all the alder trees to a 2-inch top diameter; that in board feet includes the merchantable contents of trees 8 inches and over in diameter at breast height, taken to a top diameter of 6 inches inside the bark. To obtain volume in cords divide cubic contents by 90.

PERPETUATION OF THE SUPPLY

An adequate local supply of suitable hardwoods is unquestionably essential to the fullest industrial development of the Pacific Northwest. Several of the wood-using industries of this region owe their existence largely, if not entirely, to the presence of such raw material. The fairly rapid development of these industries in Oregon and Washington has been referred to in this bulletin. Their existence or further growth appears to depend in a large measure on the perpetuation of the supply of red alder, as the leading hardwood of the region.

Broadly speaking, two general lines of action will perpetuate the supply of red alder: (1) Some form of forest management, including protection, principally from fire; and (2) the utilization of the wood in such manner that waste will be reduced to the minimum.

The increasing use of red alder by the expanding wood-using industries within its commercial range and the advance in stumpage values suggest that this wood will prove a profitable crop to grow. Whether this is so in any given case will depend largely on the character and value of the land. Manifestly, mature stands of alder or stands approaching maturity should not be needlessly destroyed but rather protected until they can be disposed of profitably.

MANAGEMENT

The problem of management of red alder resolves itself principally into the question of protecting the stands already started (both mature and immature) and of providing favorable conditions for its propagation on lands which are not producing any other forest crop and which are not needed for agricultural purposes.

Mature stands present no special problem except that care be taken to keep out fire and to prevent indiscriminate cutting or slashing when the land is not needed for other purposes. After the stand has reached about 50 years of age its growth is on the decline and efforts should be made to realize upon it before growth ceases entirely. Thinnings for cordwood, poles, etc., if properly made, should in no way injure the stand, and will probably result in increased growth of such trees as are liberated.

Immature stands, from the seedling stage up to 30 or 40 years of age, need above all protection from needless cutting or slashing. These young stands have an exceedingly rapid growth in volume; they can furnish merchantable material at 40 or 50 years of age, besides yielding before this time a considerable quantity of small material suitable for firewood, etc.

Where alder occurs in pure stands, as in the coast region of Oregon and Washington, it is largely a temporary type, which will give place under natural conditions to more tolerant and longer-lived coniferous species, chiefly Douglas fir or Sitka spruce, which are generally better suited to these hillsides. Found usually on severely burned areas, where the conifer stand has been destroyed and the soil impoverished, the alder with its humus-producing leaves and twigs and nitrogen-producing roots[7] builds up the soil, bringing back to the area the conditions favorable to the growth of conifers. Alder stands of this character should be protected so far as practicable, and utilized before decadence sets in.

For sustained crop production red alder warrants careful consideration. In seed production it is very prolific, and from all observations will restock burns and recently cut-over lands naturally to a satisfactory degree within a few years after the timber has been removed. Therefore, natural reproduction can undoubtedly be depended upon for the new crop. Comparatively young trees bear considerable seed and scatter it widely, so that a cut-over area may reseed satisfactorily from a few well-placed trees not needed for timber, assisted by others bordering the cutting. Some care, however, must be taken to plan the cutting operations against the prevailing wind so that seed from the adjacent standing timber will blow onto the cut-over area.

It is not thought necessary to burn the slash left upon the ground, as a silvicultural measure; nor from the standpoint of fire protection is burning generally needful, for alder slash customarily decays very rapidly, and most of the stands are in areas of comparatively low fire hazard.

The financial return that can be expected from growing red alder is problematical, depending largely on the future value of the stumpage. Assuming that the yields at maturity, or from 45 to 55 years, are correctly indicated in Table 15, averaging 25,000 board feet or more per acre, and that alder saw timber by that time will be worth $7 per thousand board feet on the stump, the gross value per acre in 50 years would be $175. It is not unreasonable to suppose, however, that stands 50 years of age, where they have been given some care, will yield 30,000 board feet per acre, and that stumpage by that time will have advanced to at least $10 per thousand feet, yielding a gross value of $300 an acre or more.

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[7] Examination of the nodules on the roots of red alder by the Forest Products Laboratory shows that they contain nitrogen-fixing bacteria. See Johnson, H. M., Alnus oregona: its value as a forest type on the Siuslaw National Forest. Jour. Forestry 15: 981–987. 1917.

The facts indicate that for many reasons red alder is a desirable tree to perpetuate as a forest type in the Pacific Northwest. The ease with which a crop is obtained naturally, its comparatively rapid growth and the short period required to produce merchantable timber, its ability to grow on rather inferior sites where atmospheric conditions and soil moisture are favorable, its comparatively low fire risk, and, lastly, its undoubtedly increasing use and rising stumpage values all point to the desirability of keeping certain types of land permanently producing this species.

BETTER UTILIZATION

Present utilization of red alder is in the main satisfactory, in so far as methods of manufacture and use are considered that are obviously economically feasible. The care that some companies are already exercising, however, not alone in the woods but in the sawmills and factories as well, indicates that still closer utilization is practicable. Wherever such improvement can be made it will assist materially in the perpetuation of the supply.

Failure to cut low stumps and possibly to utilize all of the merchantable tops of trees is resulting in some waste. Stump heights range from 16 to 24 inches, depending on the character of ground and the cutting policy of individual companies. Even under the most unfavorable conditions a stump height of 16 inches seems to be ample, and in most instances a lower stump is entirely feasible.

Utilization of the tree tops to a diameter less than 6 inches would hardly be profitable. At about this point the taper of the tree is excessive and the quality of the timber becomes exceedingly poor. A larger diameter may be necessitated by the limby character of the top or because of the freight rates, on logs, which in many cases make 8-foot logs more profitable than longer ones. Otherwise, a top larger than 6 inches may indicate needless waste.

Because much of the alder lumber is cut in small mills, maintaining limited and ineffectively installed equipment, a certain amount is irregular in width and thickness. Wood-using factories can and do utilize lumber that is not up to specification, but the yield is naturally lower than normal. The use of circular saws by these small mills also results in waste, because of the wide kerf cut. However, this waste is unavoidable, for band saws in this type of mill are not practical. Waste in seasoning and storage of lumber is not excessive and much that occurs can be avoided with reasonable care.

Although the study on which this bulletin is based did not include a careful and systematic survey of wood waste in factories using red alder lumber, incidental observations indicate that much of this has been eliminated in the majority of such factories. This is particularly true of factories producing chairs exclusively, because of the character of the articles manufactured and also because the majority of these factories utilize round-edged lumber. Even the factories remanufacturing square-edged lumber into dimension stock exercise care to avoid waste, as a rule. Some occurs of necessity in the cutting-up process, but a large percentage of this is utilized in the form of glued or built-up stock for cores and different parts of the articles manufactured. Scraps of lumber 1 by 4 by 6 inches or even smaller are utilized in this way.

Only one furniture company is known to use round-edged alder lumber. This company, like the chair companies, produces its supply of alder lumber at its own factory from purchased logs. It may not be economically feasible for all factories to utilize round-edged lumber, but the general adoption of the practice would unquestionably result in a considerable saving of wood.

From the fact that the chair companies using round-edged lumber produce it at their own factories, the inference is that this policy is economically sounder under existing conditions than that of buying such lumber in the open market. The difference between log and lumber transportation costs, together with the large overrun in sawing alder logs may of course be a factor in some instances.

Round-edged lumber costs somewhat less to produce than square-edged lumber, but the cost of transporting it to the factories is greater per unit of cutting than for square-edged lumber. Also the percentage of material which is lost in the factory remanufacturing process is, when based on the gross content of round-edged pieces, proportionately higher. Nevertheless, if care in cutting up is used, a round-edged board of a specified commercial board-foot content should, because of the nature of cuttings required, yield more net footage, other conditions being equal, than square-edged material. Because many short cuttings are required, the board can be cross cut at advantageous points and the maximum width of that short section be utilized.

Data collected in detailed studies of eastern chair factories on the use of round-edged, mill-run lumber[8] show a higher loss of material in comparison with the material lost in cutting up square-edged pieces. This is due principally to two facts: Mill-run material in the eastern chair factories is usually No. 3 and better, cut from a rather low grade of log, and in the factory no care is used in cross cutting at points which will yield the greatest quantity of cutting possible.

VOLUME TABLES

Table 16 shows the average contents in board feet of trees of different diameters for various total heights. The trees on which this table was based were all actually scaled by calipering them as 8-foot logs, the stumps averaging about 1 foot in height. The trees were considered merchantable up to 6 inches in diameter inside the bark.

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[8] These studies were made by the Forest Products Laboratory as a part of the general study of the wood requirements of the chair industry, with the following report: Upson, A. T., and Benson, A. O., Production and Use of Small Dimension Stock in the Chair Industry. 104 pp., illus. Chicago, Ill., 1923.

TABLE 16.—*Volume table for red alder*[1]

Griffin, Wilcox Scribner rule

Diameter at breast height	Total height in feet							Average volume for all heights	Height of average tree
	60	70	80	90	100	110	120		
	Volume in board feet [1]								
Inches:								*Bd. ft.*	*Feet*
8	12	30	48	54	--------	--------	--------	30	71
9	17	36	55	74	--------	--------	--------	47	76
10	22	46	70	94	118	--------	--------	75	80
11	26	57	85	115	140	--------	--------	101	84
12	31	68	105	140	170	--------	--------	135	88
13	--------	82	127	170	205	235	--------	176	91
14	--------	95	150	200	242	278	--------	219	94
15	--------	108	170	230	275	320	365	263	97
16	--------	120	195	260	314	365	415	308	99
17	--------	--------	218	290	352	410	458	357	101
18	--------	--------	245	325	392	460	512	406	102.5
19	--------	--------	275	362	437	506	568	459	104
20	--------	--------	305	400	485	561	632	518	105
21	--------	--------	--------	445	536	620	700	590	106
22	--------	--------	--------	493	585	683	770	668	106.5
23	--------	--------	--------	550	650	750	840	749	107
24	--------	--------	--------	610	710	810	905	837	107

[1] Contents inside bark. No allowance made for defect or breakage. Frustum form factor method used. Volumes read from curves. Based on 8-foot logs taken to a top diameter of 6 inches, from 115 trees.

Table 17 shows the average contents in cubic feet of trees of different diameters for various heights. This was obtained by measuring the diameters of the 8-foot logs at the middle, up to 2 inches in diameter inside the bark. It is therefore a very accurate guide to the total quantity of wood in a tree.

TABLE 17.—*Volume table for red alder*[1]

Griffin, Wilcox

Diameter at breast height	Total height in feet							Average volume for all heights	Height of average tree
	60	70	80	90	100	110	120		
	Volume in cubic feet								
Inches:								*Cu. ft.*	*Feet*
8	7.2	11.5	15.7	--------	--------	--------	--------	11.6	71
9	8.4	13.0	17.4	21.9	--------	--------	--------	15.3	76
10	9.6	14.0	19.2	24.6	--------	--------	--------	19.3	80
11	10.8	15.7	21.9	28.1	--------	--------	--------	23.8	84
12	12.2	18.0	24.5	31.1	37.5	--------	--------	28.6	88
13	--------	20.4	27.4	34.1	41.0	--------	--------	34.3	91
14	--------	23.7	31.0	37.8	45.0	52.0	--------	40.5	94
15	--------	27.0	35.3	42.3	49.4	56.5	--------	47.0	97
16	--------	30.5	39.1	46.8	54.4	62.0	69.7	54.0	99
17	--------	--------	43.2	51.2	59.6	68.0	77.0	61.4	101
18	--------	--------	47.4	56.3	65.6	75.0	84.8	68.8	102.5
19	--------	--------	51.6	61.3	71.5	82.0	92.4	76.4	104
20	--------	--------	55.8	66.8	77.9	89.0	100.0	83.3	105
21	--------	--------	--------	71.8	84.0	96.0	108.0	92.0	106
22	--------	-------X	--------	77.6	90.2	102.9	115.5	100.5	106.5
23	--------	--------	--------	83.3	96.5	109.8	123.2	109.2	107
24	--------	--------	--------	89.0	102.4	116.8	131.0	117.6	107

[1] Contents inside bark. No allowance made for defect or breakage. Frustum form factor method used. Average, or middle, diameter of logs used. Volumes read from curves. Based on 8-foot logs taken to a top diameter of 2 inches, from 115 trees.

Table 18 shows the average merchantable contents in board feet of trees for various merchantable heights, expressed in 8-foot logs. As in the case of Table 16, the trees were considered merchantable up to 6 inches in diameter inside the bark.

TABLE 18.—*Volume table for red alder*[1]

Griffin, Wilcox

Scribner rule

Diameter at breast height	Number of 8-foot logs									Average volume for all heights	Average merchantable height
	4	5	6	7	8	9	10	11	12		
	Volume in board feet										
Inches:										*Bd.ft.*	*Feet*
8	30	40	50	------	------	------	------	------	------	30	33.5
9	36	47	57	67	------	------	------	------	------	47	41
10	46	58	71	86	98	------	------	------	------	75	6.5
11	57	73	90	106	122	138	------	------	------	101	52.5
12	68	89	109	128	147	167	------	------	------	135	57
13	------	------	132	154	179	202	------	------	------	176	61
14	------	------	155	182	210	238	265	------	------	219	65
15	------	------	177	208	240	271	302	------	------	263	69
16	------	------	------	235	272	309	346	384	------	308	72.5
17	------	------	------	262	303	346	388	430	------	357	75.5
18	------	------	------	295	340	386	432	479	------	406	78
19	------	------	------	328	380	431	482	533	------	459	81
20	------	------	------	365	421	477	533	590	645	518	83
21	------	------	------	404	465	527	590	654	715	590	84
22	------	------	------	447	515	575	650	720	787	668	85
23	------	------	------	------	570	640	712	785	855	749	86
24	------	------	------	------	631	704	776	850	924	837	86.5

[1] No allowance for defect or breakage. Frustum form factor method used. Volumes read from curves. Based on 115 trees taken to a top diameter of 6 inches.

SUMMARY

Red alder, the leading hardwood of the Pacific Northwest, grows on the Pacific coast from southern Alaska to southern California, but reaches its best development in Washington and Oregon. Here it generally occurs in mixture with other trees, except in moist locations where it often forms practically pure stands.

Red alder is a small, short-lived tree maturing in 50 or 60 years and reaching at that age a diameter of about 18 inches. The merchantable stand in Oregon and Washington is estimated at 1,100,000,000 board feet or somewhat greater than the estimated stand of black walnut of the East. The lumber cut in 1923 amounted to approximately 13,500,000 board feet, which was only 0.2 per cent of the total cut of hardwood lumber in the United States. The importance of red alder is due to the scarcity of other hardwoods in the Pacific Northwest.

The wood is light brown, soft, moderately light in weight. It is rather weak, has poor shock resisting ability, is moderately stiff, shrinks but little, and is not durable. Its chief use is for medium-grade furniture, especially for posts, stretchers, and other turned parts where its ease of working and fair degree of stiffness are advantageous. In 1923 about 90 per cent of the cut was used for making furniture and chairs by factories in Washington and Oregon. Red alder made up about one-half the total amount of wood used by these factories.

The ease with which a stand of red alder can be obtained, the rapid growth of the tree even on poor sites, its comparatively low fire risk, and the increasing value of the wood, all point to the desirability of making provision for a future supply of this timber.

CLASSIFIED LIST OF USES FOR RED ALDER

REPORTED USES

Auto bodies, framework.
Backs, mirror.
Baskets—grape, grip.
Bedroom sets, enamel finish.
Bedsteads, enamel finish.
Boards—pressing, seam.
Booths, telephone.
Boxes, grape.
Brushes—backs, handles.
Buffets—drawers, framework, panels.
Cabinets—kitchen, medicine, sewing, toilet, towel.
Cases, wall.
Chairs — with enamel finish — bedroom, breakfast, dressing, and nursery; high, kitchen, frames for diners and overstuffed; legs for diners, office, and rockers; posts for diners and office; rails for diners and rockers; slats for diners and rockers; spindles for rockers; stretchers for diners, office, and rockers.
Charcoal.
Chiffoniers—framework, drawers, panels.
Closets, china.
Core stock, high-grade panels.
Cribs, nursery.
Davenports, framework.
Davenport beds, framework.
Dishes—outing, wire-end.
Drawers—backs, bottoms, slides.
Dressers—enamel finish—drawers, framework, panels.
Ferneries.
Frames—picture, mirror.
Hallocks, berry.
Handles—brush, file, tool.
Hangers, coat—17 styles.
Ladders, rungs.
Lamps—floor, table.
Molding, picture.
Molds, butter.
Panels—core, for furniture and for wall.
Pedestals—floor, table.
Penholders.
Pins, clothes.
Plugs, paper.
Racks—display, music, hat, towel, wall.
Rungs, ladder.
Shelving.
Stands—flower, lamp, smoke, telephone, umbrella.
Sticks—candle, clothes.
Stools—foot, kitchen, nursery, office, telephone.
Tables — with enamel finish — breakfast, dressing, nursery; framework for extension; legs; panels for breakfast, dining, library, office, parlor; rails, slides, stretchers.
Tabourettes.
Toggles, tent.

POSSIBLE USES FOR RED ALDER

Backs—clock case, musical instrument.
Beehives.
Binding, school blackboard.
Blocks, thermometer.
Boards—drawing, piano fall, calendar mounting, sign.
Boxes and crates—bottle, bread, cake, candy, cigar, cracker, crayon, dried fish, fruit, grain, macaroni, rough, seed, coal sieve, tea, plug tobacco, trunk, veneer.
Buckets.
Bungs.
Butter labels.
Butter molds.
Butter tubs and pails.
Carriages, baby.
Cases, egg.
Cupboards, kitchen.
Dairy supplies.
Dowels.
Driers, clothes.
Drums, fanning-mill.
Egg carriers.
Erasers, blackboard.
Forms, hosiery-display.
Hoppers—agricultural implements; machinery for mill, flour.
Keys, piano, organ.
Kiddie coops.
Looms.
Organs—pipe, reed.
Paper, book and magazine (soda process).
Patterns or molds, brick, fire.
Poles, curtain.
Pulleys.
Racks, piano—key.
Refrigerators, outside—enamel finish.
Rollers—map, shade.
Slats, feeder, implement—agricultural.
Strips, carpet—trim, interior, house.
Sweepers, carpet.
Toys.
Trunks, compartment.
Tubs, lard.
Wheels, buffer.

Uses for which red alder would probably be suitable but which might necessitate a change in design of the article in order to insure its adaptability:

Actions—piano; piano—player.
Bases—electrotype, cut.
Bellows—piano, organ.
Bobbins.
Bobs, fishing.
Bottoms, key, case, piano.
Chests, organ.
Frames—camera, organ.
Humidors.
Incubators.
Necks, instrument—stringed.
Parts—camera; organ, interior—reed and pipe; piano, interior—player piano; billiard table.
Reels.
Spindles.
Spools.

DIRECTORY OF PRODUCERS AND CONSUMERS

The following is a list of principal producers and consumers of alder in Oregon and Washington, including loggers, lumber manufacturers, and wood-using factories, by States. Many of those listed cooperated in the collection of the data contained in this bulletin. Operators who produce more than one product appear in this list under more than one heading.

OREGON

LOGGERS

Alderwood Mill Co	Grand Ronde.
Bram, Fred	Troutdale.
Crosswell, L. E	Linneman.
Crowder, L. C	Vernonia.
Davis, F. J	Bull Run.
E. & H. Lumber Co	Hebo.
Frye, J. A	Portland.
Granger, Wm	Bull Run.
Graves, Geo. T	Black Rock.
Hornschuch, T. R	Hebo.
Judd, Geo	Boring.
Larsen & Pratt	Clatskanie.
McCartney, E. D	Linnton.
May, A. L	Dayton.
Mead, M. M	Banks.
Powell & Nand	Clatskanie.
Rasor, J. V	Portland.
Roth, Wm	Astoria.
Waters, E. E	Lebanon.

LUMBER MANUFACTURES

Alderwood Mill Co	Grand Ronde.
Bittner Plug Mill	Sandy.
Brand, John J	Clatskanie.
Carman Manufacturing Co	Portland.
Doernbecher Manufacturing Co	Portland.
E. & H. Lumber Co	Hebo.
Hornschuch, T. R	Hebo.
Larsen & Pratt	Clatskanie.
Oregon Chair Co	Portland.
Waters, E. E	Lebanon.
Youngs Bay Lumber Co	Astoria.

FURNITURE MANUFACTURES

Beaver State Furniture Co	Portland.
Carman Manufacturing Co	Portland.
Columbia Furniture & Fixture Co	Portland.
Doernbecher Manufacturing Co	Portland.
Emerwood Panel & Top Co	Portland.
Freeland Table Co	Portland.
Portland Furniture Manufacturing Co	Portland.
Sheridan Furniture Co	Sheridan.
Westmade Desk Co	Portland.

CHAIR MANUFACTURES

Carman Manufacturing Co	Portland.
Doernbecher Manufacturing Co	Portland.
Oregon Chair Co	Portland.

WOODENWARE AND NOVELTY MANUFACTURES

Baker Manufacturing Co	Portland.
Mangold & Strauss	Portland.
Sheridan Furniture Co	Sheridan.

PAPER PLUG MANUFACTURES

Bittner Plug Mill	Sandy.

WASHINGTON

LOGGERS

Bearse, J. L. Co	Sultan.
Bliss & Armstrong	Hoquiam.
Birch & Alder Products Co	Blaine.
Cooper Lumber Co	Morton.
Drake, C. M	Black Diamond.
Graham, R. C	Knappton.
Kitsap Alder Co	Suquamish.
Lockridge & Deeter	Nooksack.
Loebe, A. A	Woodland.
Patterson, O. M	Hoquiam.
Stover, Chas	Kelso.
Swart, E. C	Woodland.

LUMBER MANUFACTURERS

Alder & Maple Products Co	Auburn.
Bearse, J. L. Co	Sultan.
Biel, O. L	Renton.
Birch & Alder Products Co	Blaine.
Buffelen Lumber Co	Tacoma.
Continental Lumber Co	Seattle.
Coleman, B. F	Des Moines.
Cooper Lumber Co	Morton.
Drake, C. M	Black Diamond.
Farrell, J. M. & Son	Seattle.
Hall, W. E	Kent.
Hough & Mullins	Edmonds.
Kitsap Alder Co	Suquamish.
Lockridge & Deeter	Nooksack.
Loebe, A. A	Woodland.
Mead Lumber & Shingle Co	Seattle.
Northwest Chair Co	Tacoma.
Pacific Chair Co	Seattle.
Scharich & Dougherty	Everett.
Seattle Veneer & Box Co	Seattle.
Stover, Chas	Kelso.
Washington Hardwood Co	Monroe.
West Coast Chair Co	Tacoma.

FURNITURE MANUFACTURERS

Buffelen Lumber Co	Tacoma.
Carman Manufacturing Co	Tacoma.
Cottage Furniture Manufacturing Co	Seattle.
Davidson, V., Furniture Manufacturing Co	Seattle.
General Furniture Co	Seattle.
Gregory Furniture Manufacturing Co	Tacoma.
Harmon, F. S. & Co	Tacoma.
Koster Products Co	Vancouver.
Superior Furniture Co	Tacoma.
Vans Hardwood Co	Olympia.
Washington Furniture Manufacturing Co	Seattle.
Washington Manufacturing Co	Seattle.
Washington Parlor Furniture Co	Tacoma.
Waterpower Furniture Manufacturing Co	Tacoma.
Wooden Specialty Manufacturing Co	Seattle.

CHAIR AND CHAIR STOCK MANUFACTURERS

Anderson Chair Co	Seattle.
Buffelen Lumber Co	Tacoma.
General Furniture Co	Seattle.
Gregory Furniture Manufacturing Co	Tacoma.
Northwest Chair Co	Tacoma.
Pacific Chair Co	Seattle.
Superior Furniture Co	Tacoma.
Vans Hardwood Co	Olympia.
Washington Furniture Manufacturing Co	Seattle.
Waterpower Furniture Manufacturing Co	Tacoma.
West Coast Chair Co	Tacoma.
Wooden Specialty Manufacturing Co	Seattle.

VENEER MANUFACTURERS

Buffelen Lumber Co	Tacoma.
Seattle Box & Veneer Co	Seattle.

FIXTURE MANUFACTURERS

Hubbard Cabinet Co	Tacoma.
Spokane Woodworking Co	Spokane.
Worthen-Martin Co	Seattle.

MISCELLANEOUS

Carsten Packing Co	Tacoma.
DuPont Powder Co	DuPont.
Howard Manufacturing Co	Seattle.
Pioneer Auto Works	Tacoma.
Puget Sound Basket Co	Seattle.
Richards Brush Co	Seattle.
Scharich & Dougherty	Everett.

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September 2, 1926

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